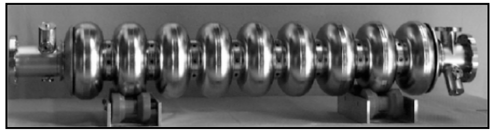


Preparing for Industrialization of ILC SCRF Cavity and Cryomodule

Akira Yamamoto, Marc Ross, and Nick Walker

ILC-GDE, Project Managers

To be presented at ILC-PAC, Eugene, Nov., 11, 2010

Outline

- Introduction
  - What was advised by the 4th ILC-PAC?
  - ILC -SCRF cost effective production
- Strategy for Preparing Industrialization
  - Learn Experience
  - Laboratory's (own) effort
  - Communication with industry
- Preparing Plan and Process
  - Call for response w/ ILC preliminary specifications
  - Integrate information from laboratories and industry
  - Establish the ILC SCRF industrialization model and cost estimate

What was advised by the 4th PAC to prepare for Industrialization ?

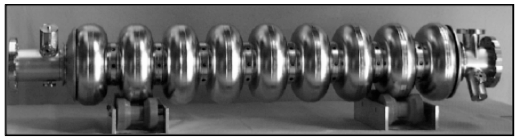
- *From the Committee recommendations on 'Accelerator':*

4. The PAC is concerned on how to go from 50% first pass SC cavity yield to 90% yield after a second pass in a mass production environment, since the only viable quality control options seem to be visual inspection and X-rays.
5. The GDE should consider cavity industrialization strategies soon. It is very unlikely that building to a performance specification will be cost effective. More realistic is to specify minimum acceptance criteria.
6. Differential cavity yield plots will provide valuable information not readily apparent in the integral yield plots presented to the PAC. For example, one can readily see if the processed cavities are drawn from one or more populations, and can more easily determine the meaning of the mean, and variation of the distribution(s).

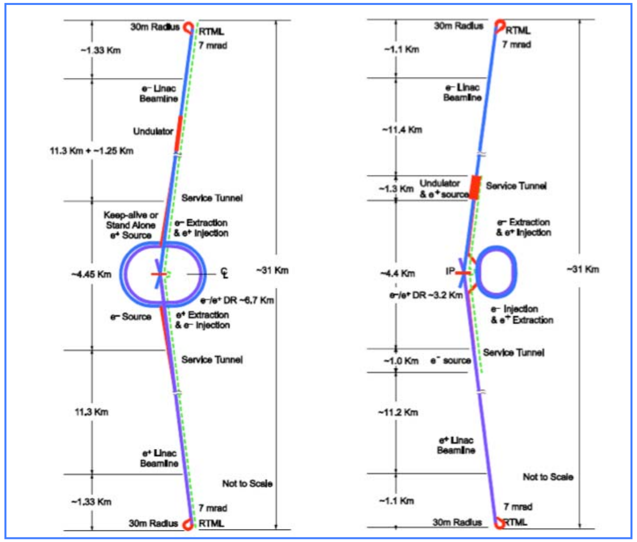
- Our response will be discussed in this report

SCRF-ML Technology Required

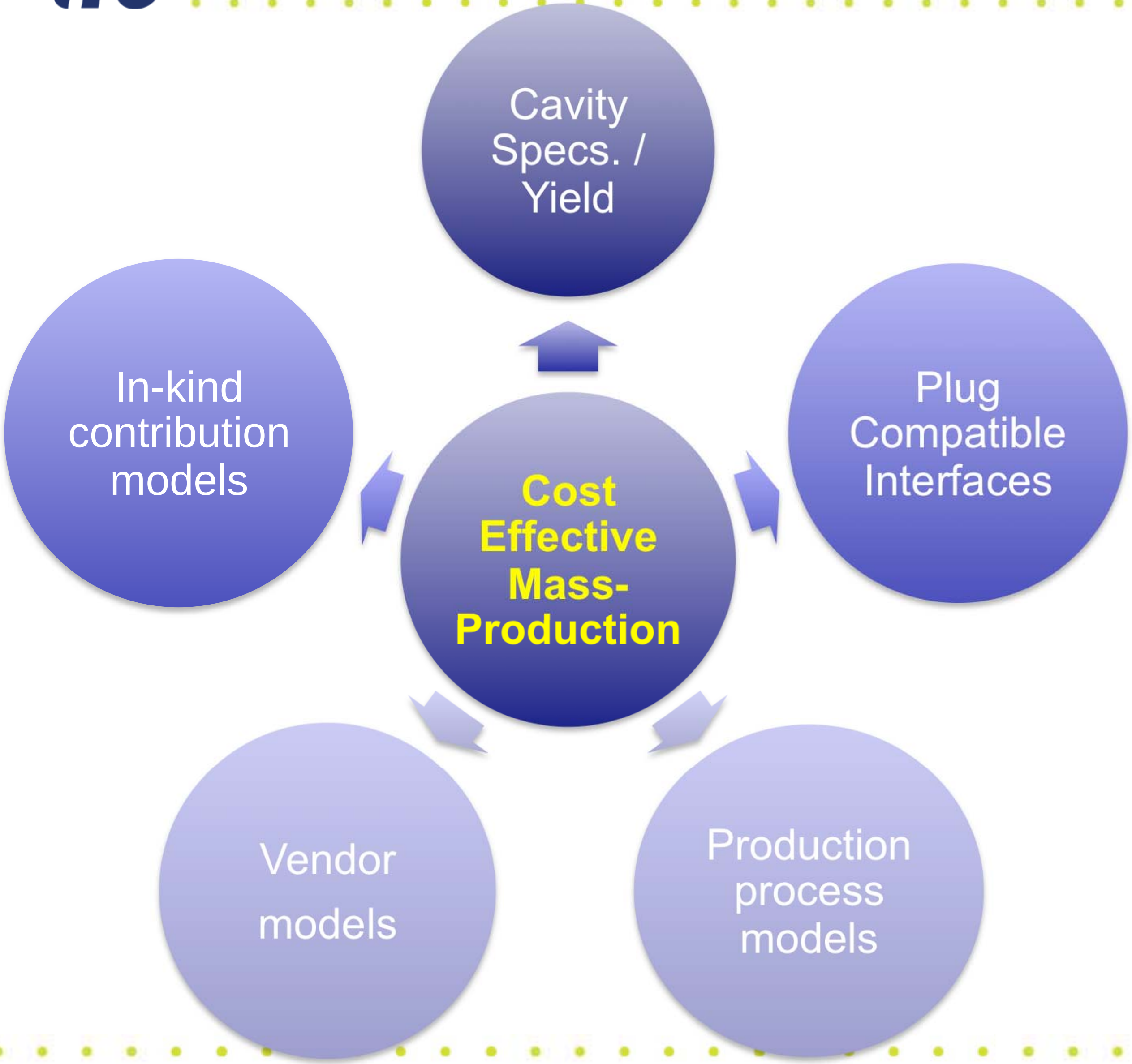
RDR Parameters	Value
C.M. Energy	500 GeV
Peak luminosity	2×10^{34} $cm^{-2}s^{-1}$
Beam Rep. rate	5 Hz
Pulse time duration	1 ms
Average beam current	9 mA (in pulse)
Av. field gradient	**31.5 MV/m**
# 9-cell cavity	**14,560**
# cryomodule	**1,680**
# RF units	**560**



RDR → SB2009



SCRF Cost Effective Production



Emphasize global approach (Multiple region mass-production)

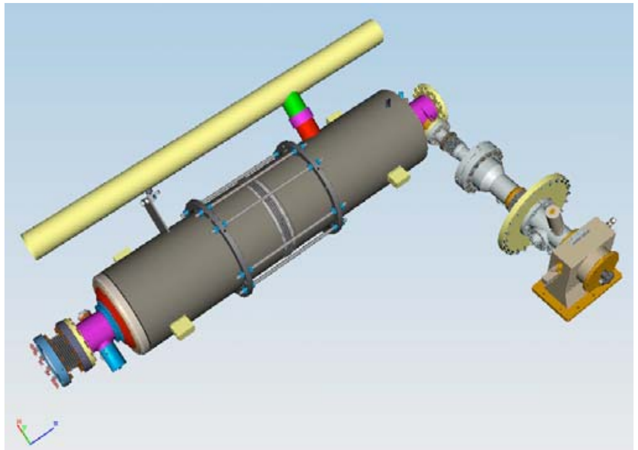
- Critically important TDP2 activity
- Learn from XFEL experience
  - 5% ILC
- Develop realistic models on which to base cost estimate
  - With industry

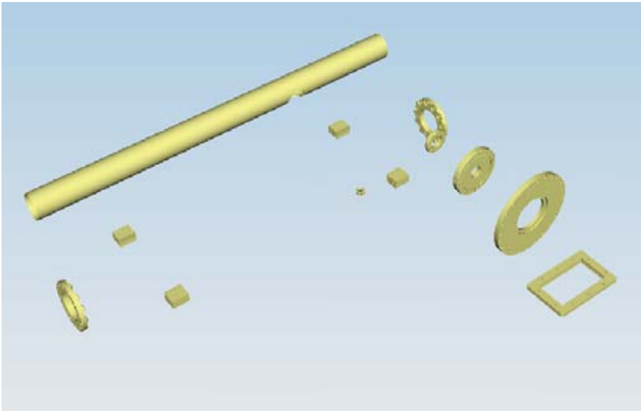
Plug-compatibility
under Construction Phases

- **R&D Phase**
  - Creative work for further improvement with keeping replaceable condition,
  - Global cooperation and share for advanced technology

- **More generally, under Construction Phase**
  - Best effort to define universal envelope / interfaces with plug compatibility,
  - Keep adequate competition with multiple-suppliers, to aid in cost reduction, while allowing variants within a common envelope,
  - Prepare for multiple organizations, with differing constraints, to be able to contribute to the ILC collaboration, and
  - Maintain intellectual interest from each contributor,
    - Encourage regional / national centers for integration and test

Plug-compatible Conditions

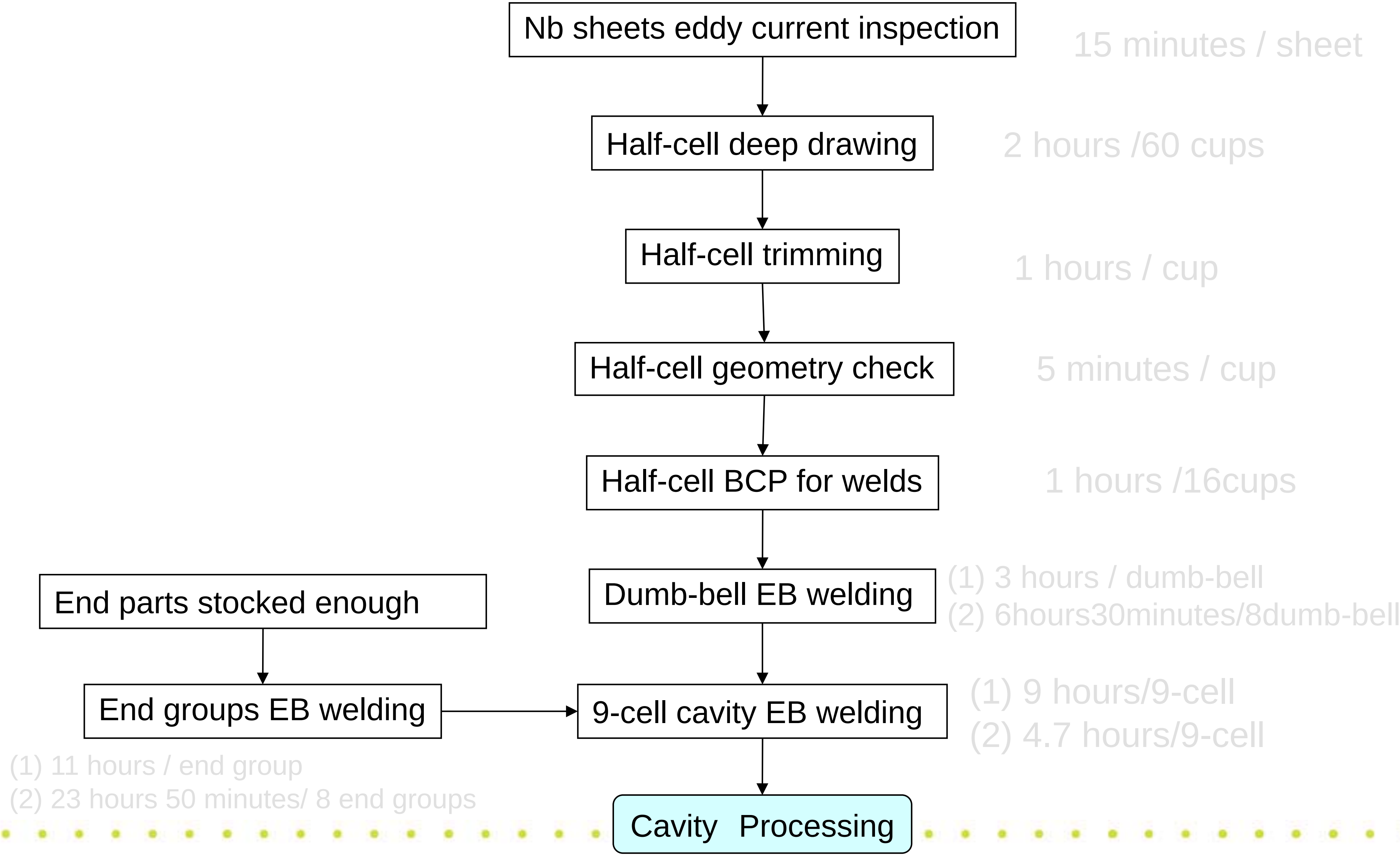




Item	Can be flexible	Plug-comp.
Cavity shape	TeSLA/ LL/RE	
Length		Fixed
Beam pipe flange		Fixed
Suspension pitch		Fixed
Tuner	Blade/Jack	
Coupler flange (warm end)		Fixed
Coupler pitch		fixed
He –in-line joint		TBD

Plug-compatible interface nearly established

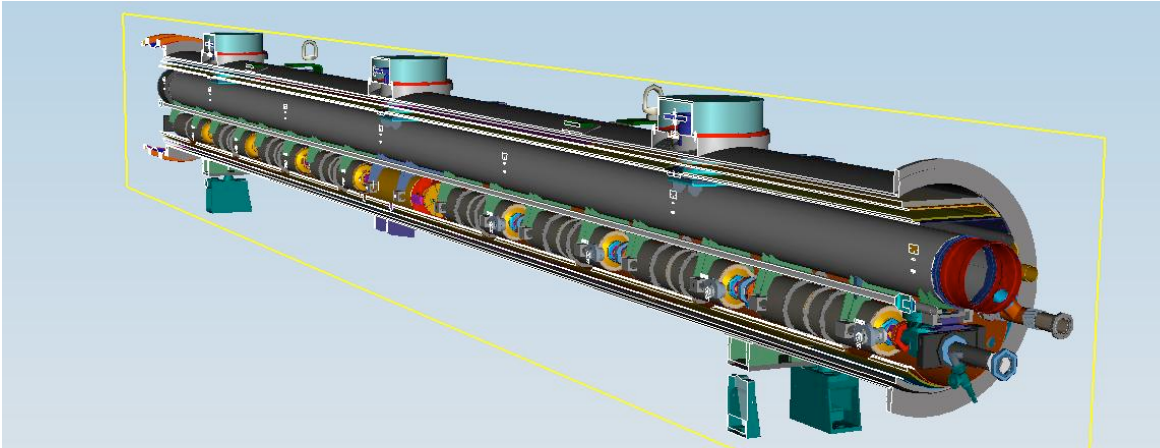
Cavity Fabrication Process

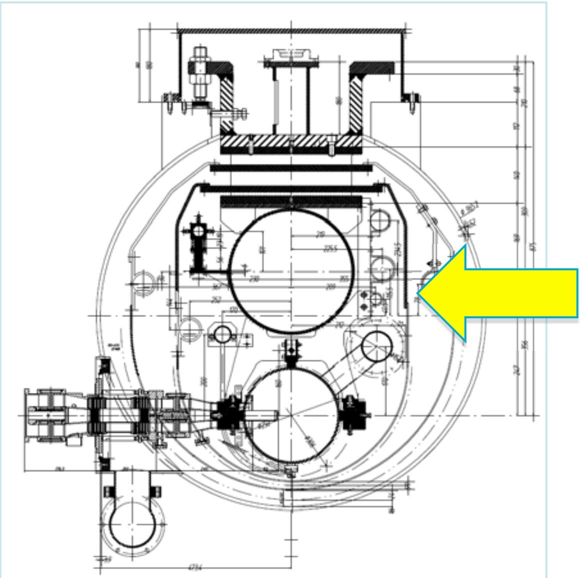


Standard Process Selected in Cavity Production and the Yield

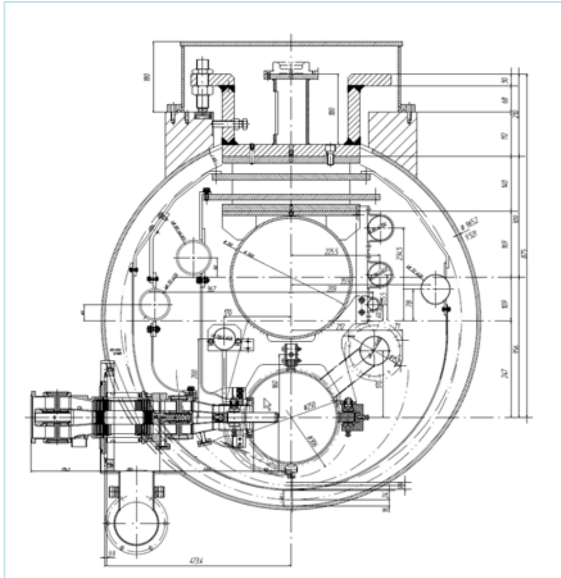
	Standard Cavity Recipe
Fabrication	Nb-sheet (Fine Grain)
	Component preparation
	Cavity assembly w/ EBW (w/ experienced venders)
Process	1st (Bulk) Electro-polishing (~150um)
	Ultrasonic degreasing with detergent, or ethanol rinse
	High-pressure pure-water rinsing
	Hydrogen degassing at > 600 C
	Field flatness tuning
	2nd Electro-polishing (~20um)
	Ultrasonic degreasing or ethanol
	High-pressure pure-water rinsing
	Antenna Assembly
	Baking at 120 C
Cold Test (vert. test)	Performance Test with temperature and mode measurement (1st / 2nd successful RF Test)

Cryomodule Plug-compatibility





Vacuum vessel
= ϕ 965.2mm



Two shield model **One shield model**

Preparing for ILC SCRF Industrialization

- Learn from previous efforts and on-going programs:
  - **Study of the TESLA project (1990's)**
    - Assuming to manage ~ 20,000 cavities
  - **R&D progress in past 10 years**
    - Varied industrialization efforts
  - **On-going Industrialization in the XFEL Project**
- Develop Industrialization Model
  - Need to adapt various governance models and in kind contribution models from multiple regions, countries, and laboratories,
  - Make our own effort to seek for the best cost-effective production technology and approach
    - An example: A pilot-plant effort at KEK
  - Communicate with industry and laboratories to seek for cost-effective manufacturing and quality control

Global Plan for SCRF R&D

Year	07	2008	2009	2010	2011	2012
Phase	TDP-1				TDP-2	
Cavity Gradient in v. test to reach 35 MV/m	→ Yield 50%				→ Yield 90%	
Cavity-string to reach 31.5 MV/m, with one-cryomodule		Global effort for string assembly and test (DESY, FNAL, INFN, KEK)				
System Test with beam acceleration			FLASH (DESY) , NML (FNAL) STF2 (KEK, test start in 2013)			
Preparation for Industrialization				Production Technology R&D		
Communication with industry:	2009: 1st step: Visit Venders (2009) 2010: 2nd step: Organize Workshop (2010) 2011: 3rd step: Send specification & receive response					

Global Plan for SCRF R&D

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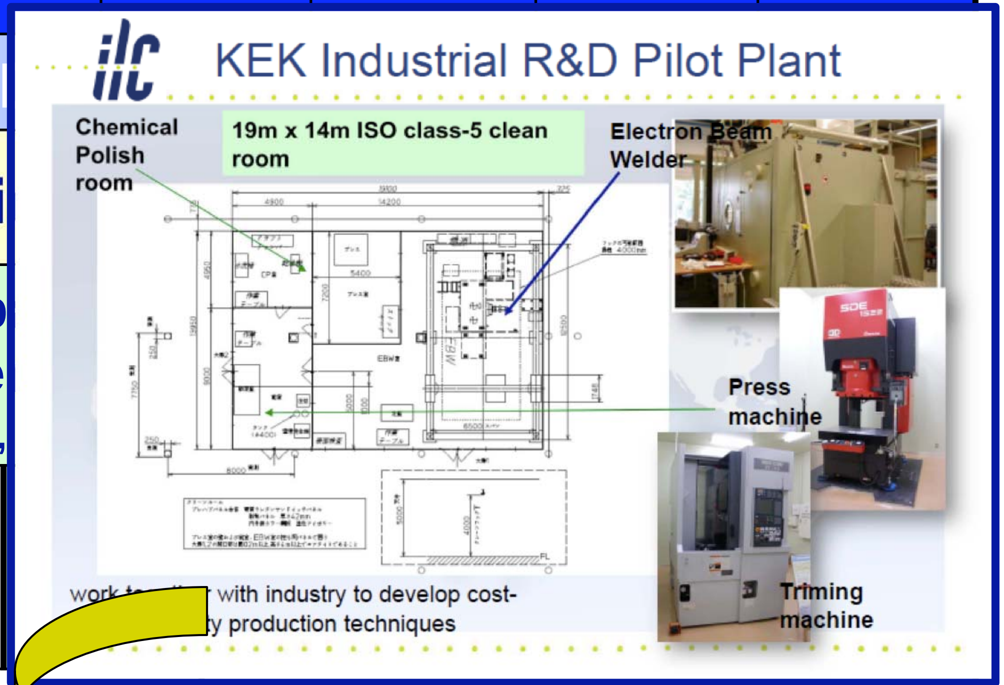
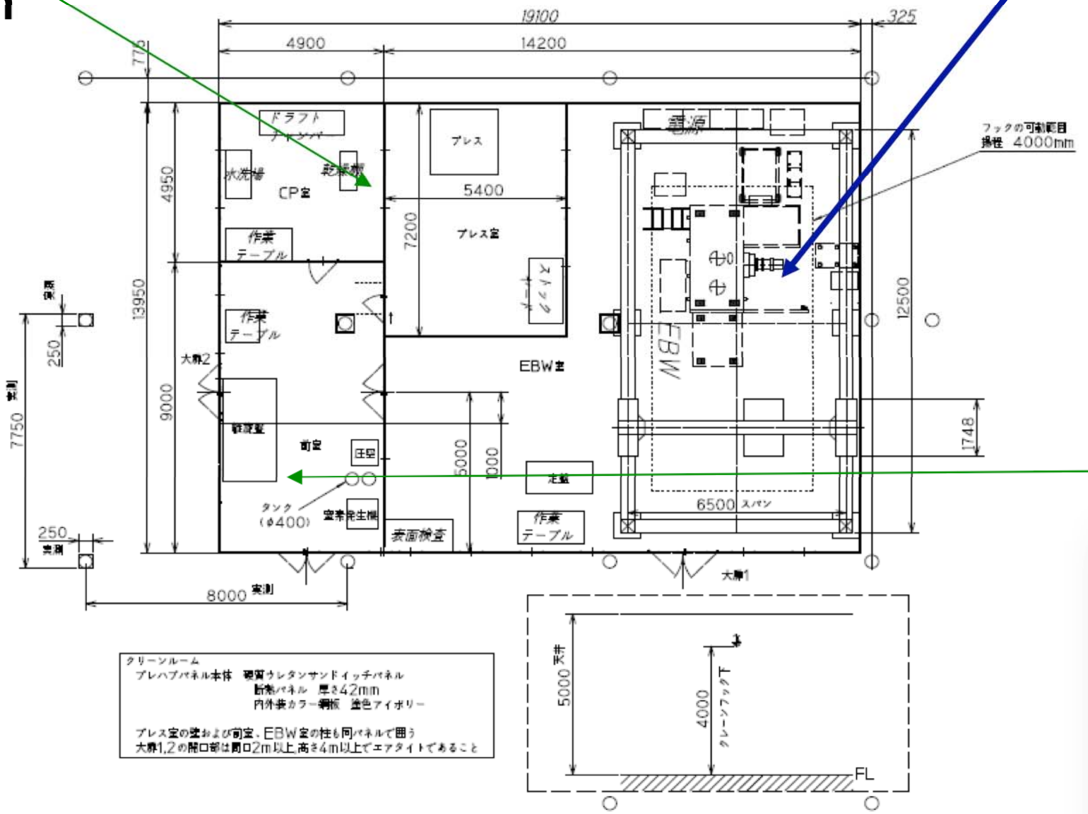


KEK: A Pilot Plant for Industrial R&D

Chemical Polish room

19m x 14m ISO class-5 clean room

Electron Beam Welder

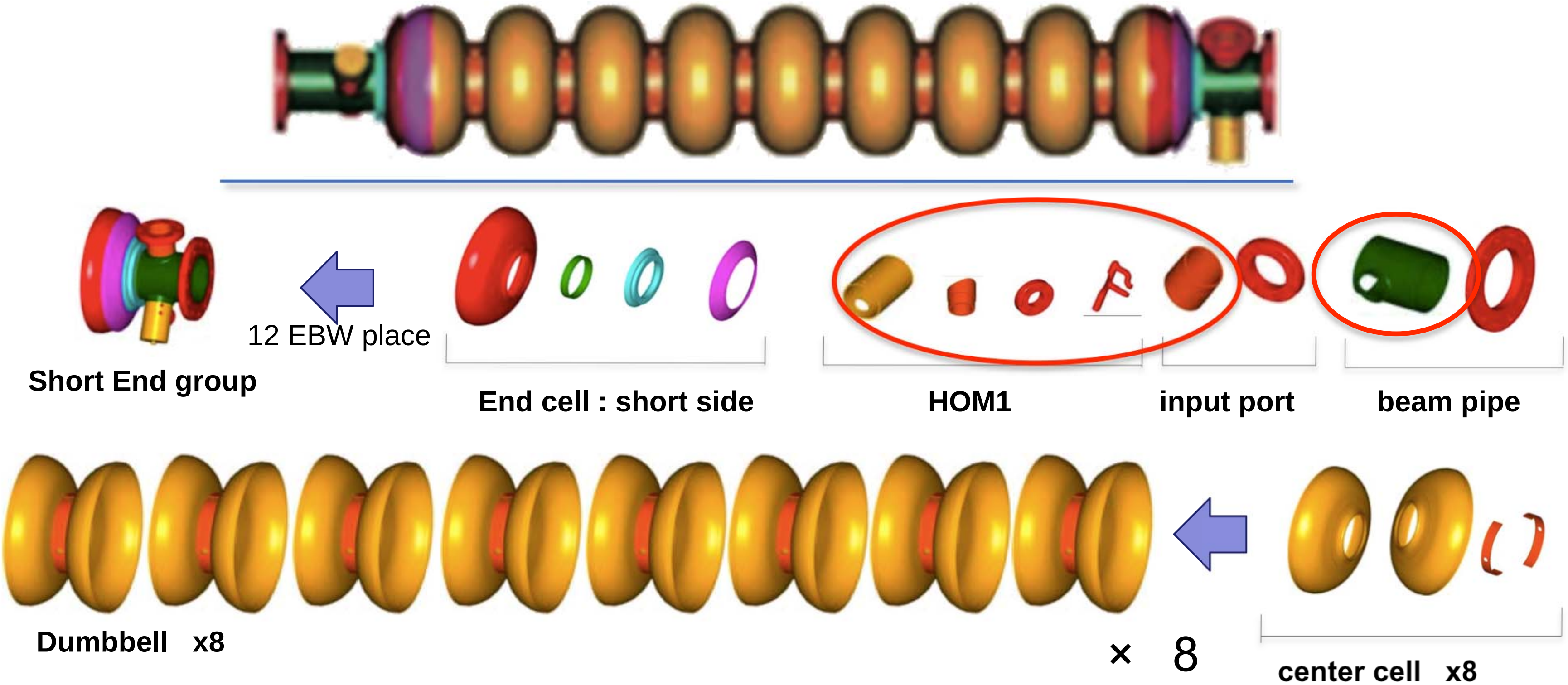


Press machine

Triming machine

work together with industry to develop cost-effective cavity production techniques

Cavity Fabrication (TESLA Cavity)



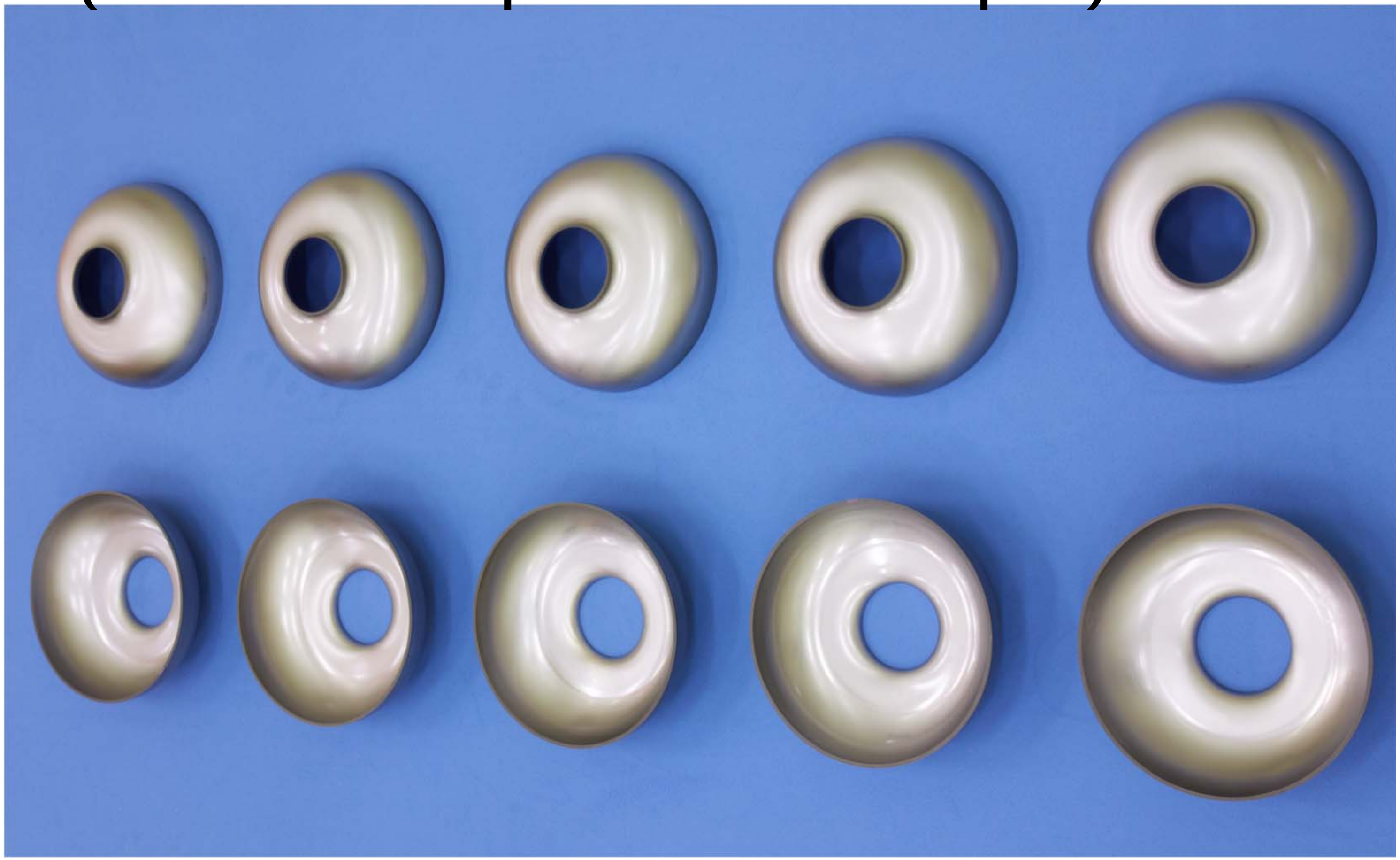
56 parts:

- Nb = 46, Nb-Ti = 10, by using press, de-burring, machining

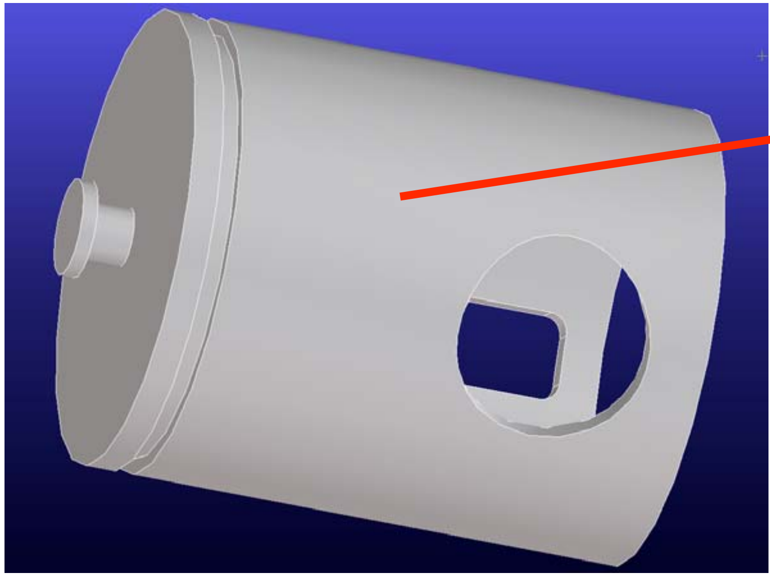
75 Electron Beam Welding (EBW) :

Nb half-cells by KEK Press Machine

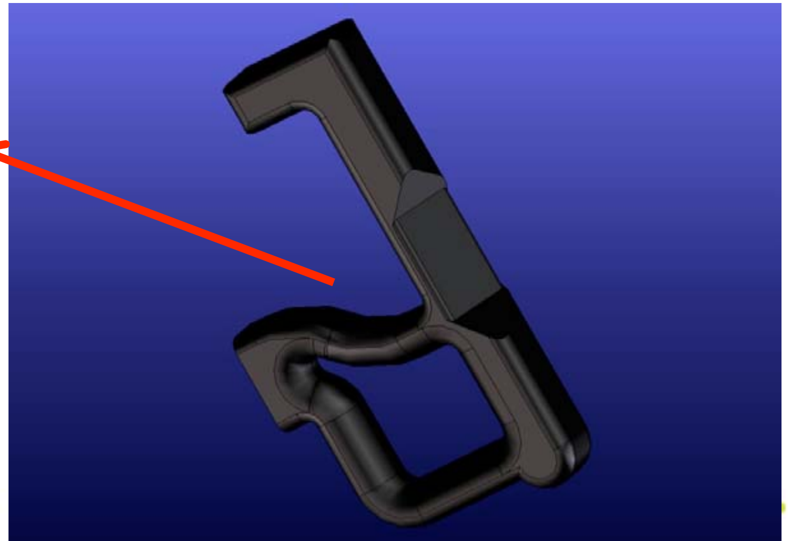
Used Press-Die Version-5
(Iteration of press die shape)



KEK-HOM-coupler R&D



(1) Deep Drawing of HOM-cup,
(2) Cut-out of holes, or deburring of holes.
(3) Develop cost effective shape of tuning knob.



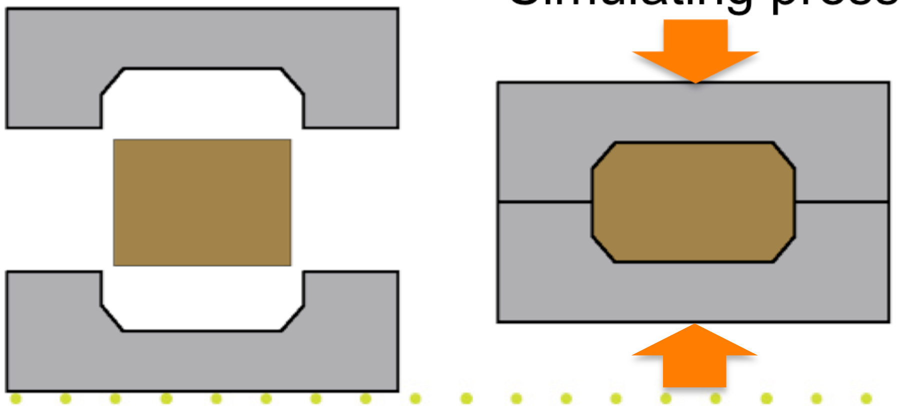
(4) Press cut-out from thick plate,
(5) Press cut-out of slope region,
(6) Press forming into design shape

Study of Press-forming was started

Use of Cu material at first, then go to Nb

Wire cut for preliminary work

Simulating press-cut of HOM Antenna

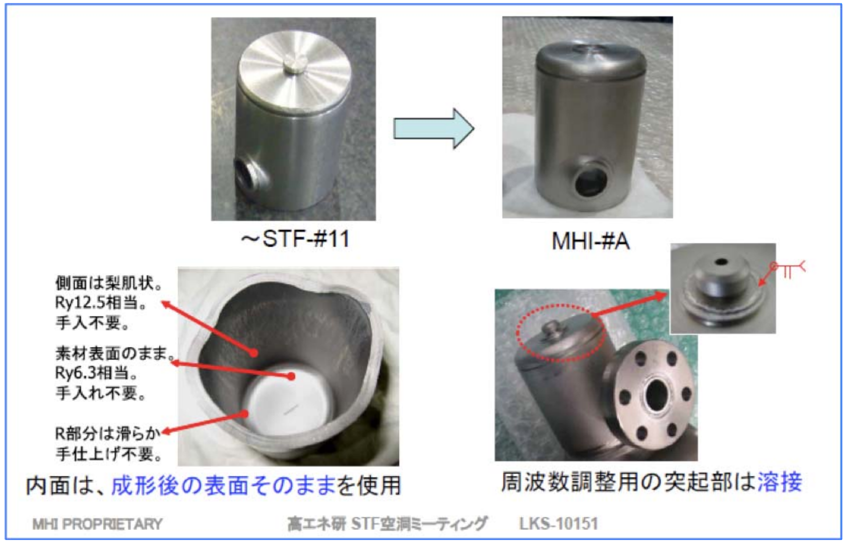


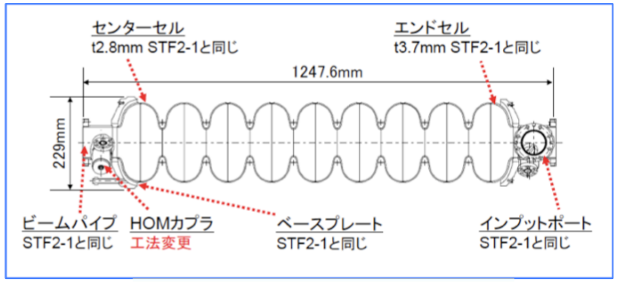
Edge shaping by press

MHI-KEK Cooperation in progress

MHI-A w/ new efforts: reached 29 MV/m

- New effort with MHI-A:
  - **Deep drawing for HOM coupler casing**
  - **Laser-beam welding trial**
    - Stiffening Ring (out-side)
    - Beam-pipe Eng-flange





MITSUBISHI HEAVY INDUSTRIES, LTD.
Our Technologies, Your Tomorrow

Global Plan for SCRF R&D

	2009	2010	2011	2012
	-1		TDP-2	
	d 50%		→ Yield 90%	
	effort for string ly and test			

Visits to SC Cavity Manufacturers in Global Industry: 2009

Notes:
AES: Advanced Energy Systems
RI: Re arch Instruments (previously, ACCEL)
MHI: ubishi Heavy Industries

A Satellite Meeting at IPAC-2010

SCRF Cavity Technology and Industrialization

Date : May 23, 2010, a full-day meeting, prior to IPAC-2010
Place: Int. Conf. Center, Kyoto, Japan
Organized by: ILC-GDE Project Managers,

beam accelerati n	
Preparati n for Industrializ tion	
Communication with industry:	2009: 1st step: Visit Vendor (2009) 2010: 2nd step: Organize Workshop (2010) 2011: 3rd step: Send specification & receive response

Next Step for Preparing Industrialization

- Plan for 2010-2011:
  - **Extend our own effort for industrialization at laboratories,**
  - **Prepare for “ILC Cavity/cryomodule Specification” and**
  - **Ask responses/advices from cavity/cryomodule vendors**

- Boundary Conditions assumed:
  - **Plug-compatible, build-print, specification**
    - Including design parameter, interfaces, manufacturing process,
    - Requirement on quality control, and minimum acceptance critera
  - **Possible mass-production model**
    - Scale of production: 4,000 ~ 8,000 (25 ~ 50 %, for example)
      - Possible industrial collaboration (grouping etc..)
    - Scale of production period: 2 + 5~6 years
      - pre-series + main production period, assuming ≥ 2 x EXFEL construction period

Draft Outline of Specification

Draft ILC-SCRF-Cavity-CFR-101024

Draft Outline

A Technical Document to be Prepared for Call-for-Response

ILC Main Linac Superconducting RF Cavity/Cryomodule:

Technical Guidelines and Specifications

for the Industrialization Study

Oct. 24, 2010

Akira Yamamoto, Marc Ross, and Nick Walker

ILC-GDE Project Managers

Prepared for Discussions at DESY, Oct. 25, 2010

Summary of Specification

This document is motivated to provide technical information to our industrial partners those who would be interested to be involved in the ILC SCRF cavity/cryomodule industrialization study and to be hopefully involved in the cavity/cryomodule manufacturing when the ILC project will be approved to be constructed.

This document intend to contain technical guideline and major specification which would be required for studying industrialization with the technical process and const estimate.

This document is to be distributed to any industrial partners those who are interested to be involved in this project and the construction. It intend to cover:

- Technical guideline for manufacturing the cavity and cryomodule components and for assembly the cavity and cryomodule,
- Technical specification for cavity components and cryomodule components, and
- Technical specification for assembling work of the cavity string into the cryomodule,

In order to scope an appropriate overview for industrialization of the cavity and cryomodule including their manufacturing time structure and cost estimate, we would like to ask possible manufacturer's response to our questions given at the end of this documents.

Two Means of Communication

1: Call-for-Response/ Request for Information (un-paid)

- **Send technical specifications to possible vendors**
  - General design parameters, plug-compatibility, fabrication process:process specification
  - 2nd series of visit to cavity/cryomodule vendors to explain the specification and to receive questions,
- **Request their response without commercial contract**
  - A standard process in advance of the call-for-tender process

2: Contracts with Specific Companies (paid)

- **Request specific studies of the industrial models and facilities**
  - receive best cost effective way of manufacturing including factory layout and working models ,
  - Property of the study result to be transferred to us (GDE/labs).

Numbers of processes trade-off in a case study of 1/6 production model:

	Fabrication of Dumb-bell with EBW	Fabrication of End group EBW	Assemble 9-cell Cavity With EBW	Number of machines and processes required	
				EB Welding	Electro-polishing
Case1 R&D phase	1 seam / welding cycle (3 hrs/3 cycle)	1 seam / welding cycle (11 hrs / 11 cycle)	one 2(4,8)-cell / welding cycle (9 hrs/9 cycle)	12	6
Case3 Mass Production Study	8 dumb-bell / welding cycle (6.5/8 hrs/3 cycle)	8 end group / welding cycle (46.7/8 hrs/ 11 cycle)	one 9-cell / 2 welding cycle (4.7 hrs / 2 cycle)	5 → 4*	6

* In case of common EBW machines for dumb-bell and end-group

Guideline for Industrialization Study

- **Global industrial market** expected for
  - **Sub-Components purchasing, w/ estaliblished tech.**
    - supplied by manufacturers with no strong constraints for regional/national balance
  - **Industrial competition encouraged for**
    - Healthy competition in bidding, and cooperation in manufacturing process with risk mitigation,
    - Keeping control of cost and schedule,
- **Laboratory responsibility** required for
  - **Assembly/integration/test work,**
    - With system engineering with intellectual interest,
    - Facility hosted by laboratories for benefit of further development and applications in each region/countries

Possible Models of Industrialization

Possible work sharing	Commercially supplied, relying on market	Region/ Laboratory responsible	Notes, constraint
# of participants	1: possible , ≥ 2: desired	≥2: most likely	
Cavity:			
Nb and raw material	Yes		
Main cell, He-Jacke	Yes with care		High Pressure Code
End-group, HOM etc.	Yes		
Input Coupler, Tuner	Yes		
Surface Process	Yes /Possible	Yes/Possible	
Integration		**Most Likely**	High Pressure Code
Cavity Perform.. Test		**Most Likely**	**Lab should be responsible**
Cryomodule:			
Vacuum vessel	Yes		
C.M. component	Yes with care		High P. code
Cavity-CM Assembly		**≥2: Most likely** **1: special case**	
Cryomodule test		**Most likely**	**Lab should be responsible**

Industry and Laboratory Cooperation

	Main Cavity/Process	Coupler	Tuner (currently)	Process, Vertical Test, Integration
EU	RI, Zanon	Thales, RI	{INFN}/TBD	DESY, Saclay
AMS	AES, Niowave, PAVAC	CPI	TBD	FNAL, JLab, Cornell,
AS	MHI, Hitachi, Toshiba	Toshiba-ET	MHI/TBD	KEK

- Possible share of responsibility:
  - **Sub-component : manufactured by industry**
  - **Integration: hosted by Lab, and worked by industry**
  - **Test: hosted and worked by Lab.**

Industrialization Models

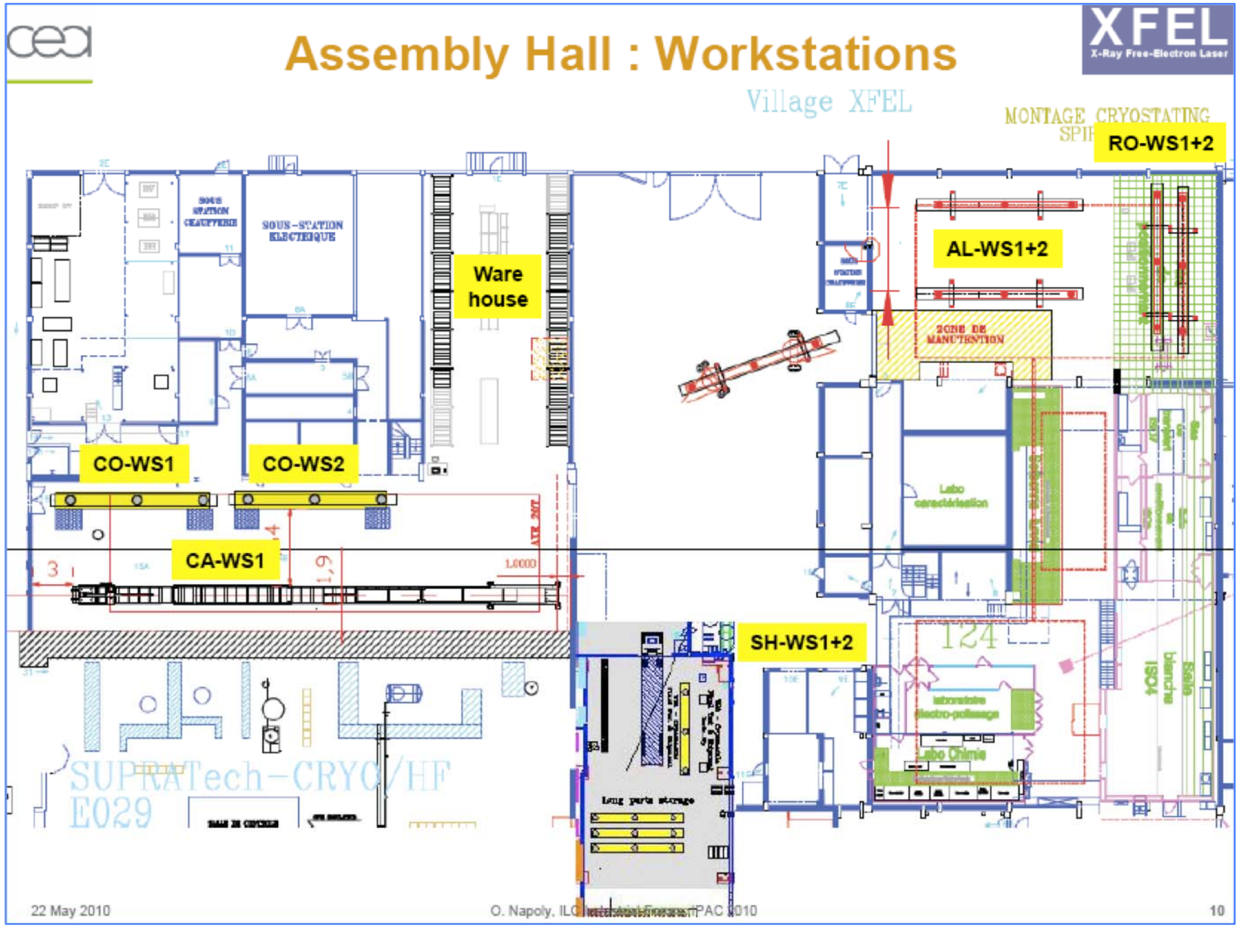
Production Models and Production Rate of SCRF Cavities					
Project	Total numbers of Cavities	Fraction Of Production Sharing	# of Cavity production	Production period (years)	Production Rate: (Cavities/day/vendor) (at 250 work-days/yr)
SNS	~ 110 (including +20%)	100 %		3	0.15
XFEL	~640	50 %		3	0.43
ILC	~ 16,000 (including +10%)	100 % 50 % 25 % 12.5 %	16,000 8,000 4,000 2,000	6 (= 2 x 3)*	10.7 5.4 2.7 1.35

*Assumption : ILC full production-rate period to be twice of production time of XFEL

Consideration on the Production Model

- Multiple vendors contribute to the manufacturing w/ a fraction less than 1/2 of total cavities (< 8,000) ,
  - **A model: RI and Zanon for E-XFEL manufacturing**
- Multiple laboratories host the integration and test
  - **A model: Saclay for E-XFEL cryomodule assembly and DESY for cavity/cryomodule tests,**
  - **Multiple hub-laboratories may be adequate for the ILC**
- In case, construction period assumed to be
  - **twice (or more) of the XFEL construction (5 ~ 6 year for ILC),**
  - **Production rate can be reduced to be a half**
    - Factor: 20 to 10,
  - **Iif four hub-laboratories host and share the work, production/ test rate becomes**
    - Factor :10 / 4 = 2.5
    - → 2.5 x XFEL production rate may be considered

XFEL Cryomodule Assembly
hosted by CEA/Saclay



- Assembly hall being prepared at Saclay

Learning at DESY, Oct. 2010

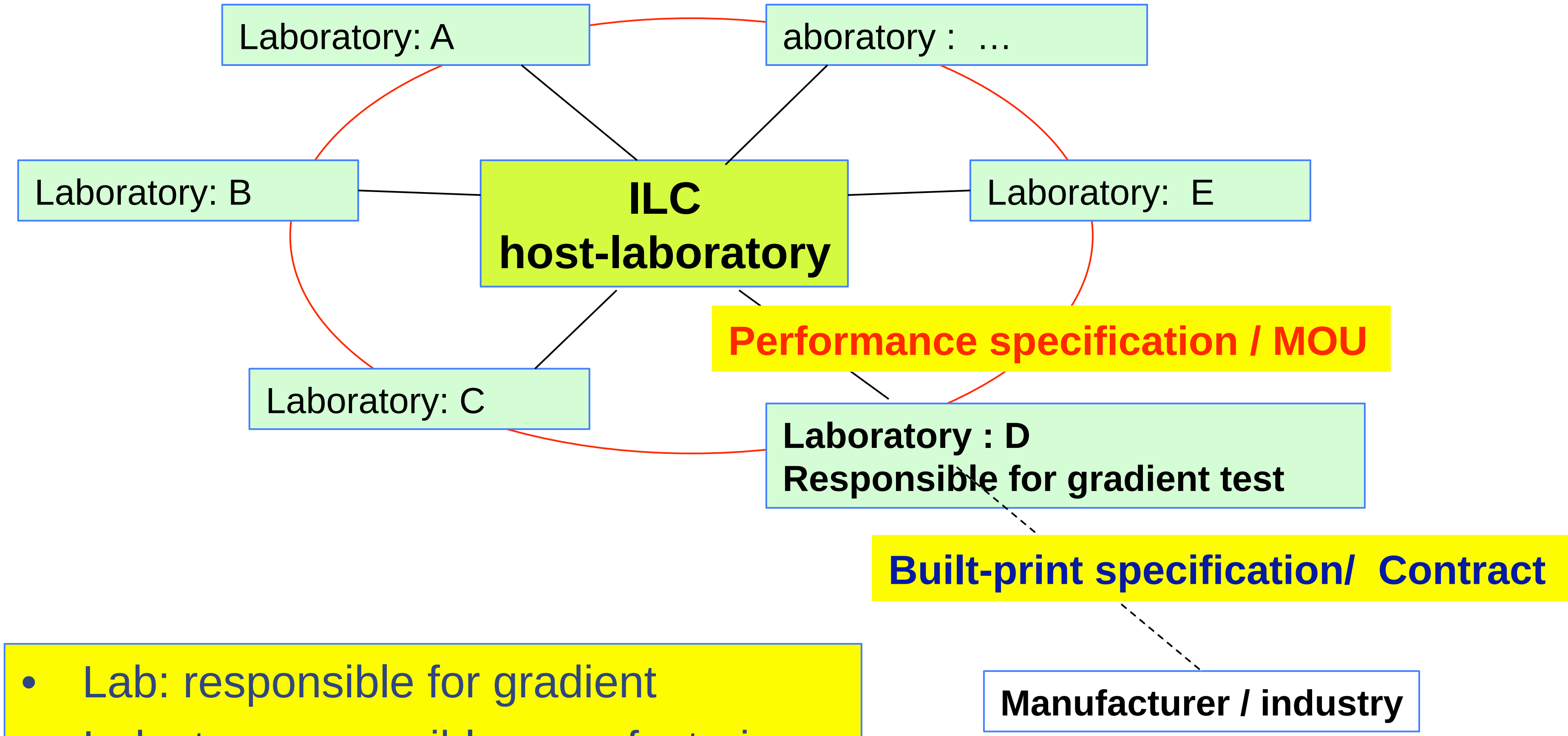
visiting XFEL cavity / cryomodule test station

- If we may have 2 ~ 3 of this test station, the ILC cavity/cryomodule test can be managed.
- We may consider factor ~ 3 instead of factor 20 (= 16,000 x ~800)

An Industrialization Model

- **Industry-based Cavity Production**
  - **Manufactured by companies,**
    - shared fraction of ½ or smaller (50 % ~ 12.5 %)
  - **According to 'built-print specification' , satisfying**
    - Minimum acceptance criteria and inspections, such as mechanical, surface, pressure, leak-tight, RF characteristics, so on,
    - Specific process such as EBW, EP, heat-treatment,
  - **Delivery from industry to laboratories with no inspection for the gradient performance**
- **Laboratory-based Cavity Performance Test**
  - **Collaborating laboratories should be responsible for the cavity gradient performance,**
    - As a deliverable in collaboration between / among laboratories,
  - **Multiple laboratories' collaboration are natural.**
  - **Delivery from laboratory to (host) laboratory with performance tested,**

An Industrialization Model and Responsibility



- Lab: responsible for gradient
- Industry: responsible manufacturing

Summary of Responsibility

to seek cost-effective cavity/crymodule manufacturing

- ILC Hosting laboratory and Collaborating Lab.
  - **'Gradient and performance' should be within an agreements,**
- ILC Hosting-lab / Participating-Lab and Vendor
  - **Manufacturing should be contracted according to**
    - Plug-compatible, **built-print specification** with minimum acceptance criteria to be well established,
    - 'Gradient performance should not be asked in contract,

Plan for Industrial Communication

Period	Occasion	Action Items
Oct. 20	IWLC-10: GDE SCRF	Discuss ‘cavity and CM specification’ and industrial model, and study plan
Oct. 25-26	Visit DESY	Learn E-XFEL cavity and cryomodule specification and procurement
Nov. 11-12	**ILC-PAC**	Report the study plan / preparation plan for industry
Dec. 9	Visit Saclay	Learn E-XFEL cryomodule assembly contract: Hosted by Saclay lab., and contracted by companies
Jan.		Complete the technical specification, and Distribute it to possible vendors
April/ May		Receive responses from vendor
Oct.		Complete new cost estimate

Summary – 1/3

- Technical base in laboratory responsibility:
  - **35 MV/m in 9-cell cavity (in vertical test)**
  - **31.5 MV/m on average, w/ spread ≤ +/- 20 % in accelerator operation**
- Performance specification for tests
  - **Applied for MOU/contract between ILC host-lab and hub-laboratories (contributing laboratories)**
- Built-print specification for manufacturing
  - **Plug-compatible design specification, with specific acceptance criteria**

Summary – 2/3

- An industrial model
  - **Multiple vendors contribute to the manufacturing w/ a fraction less than 1/2 of total cavities (< 8,000) ,**
    - A model: RI and Zanon for E-XFEL manufacturing
  - **Multiple laboratories host the integration and test**
    - A model: Saclay for E-XFEL cryomodule assembly and DESY for cavity/cryomodule tests,
    - Multiple hub-laboratories may be adequate for the ILC
  - **Construction period assumed to be twice (or more) to the XFEL construction,**
    - → a few times XFEL production rate.

Summary – 3/3

- Industrialization study requires:
  - **Own industrial R&D, to seek best cost-effective manufacturing of components,**
  - **Study of laboratory's own system integration and performance tests,**
- Communication with industry:
  - **Call for response, based on the plug-compatible, built-print specification,**
- Development of the industrial model and cost estimate by the end of 2012.

Back-up

Global Plan for SCRF R&D

Year	07	2008	2009	2010	2011	2012
Phase	TDP-1				TDP-2	
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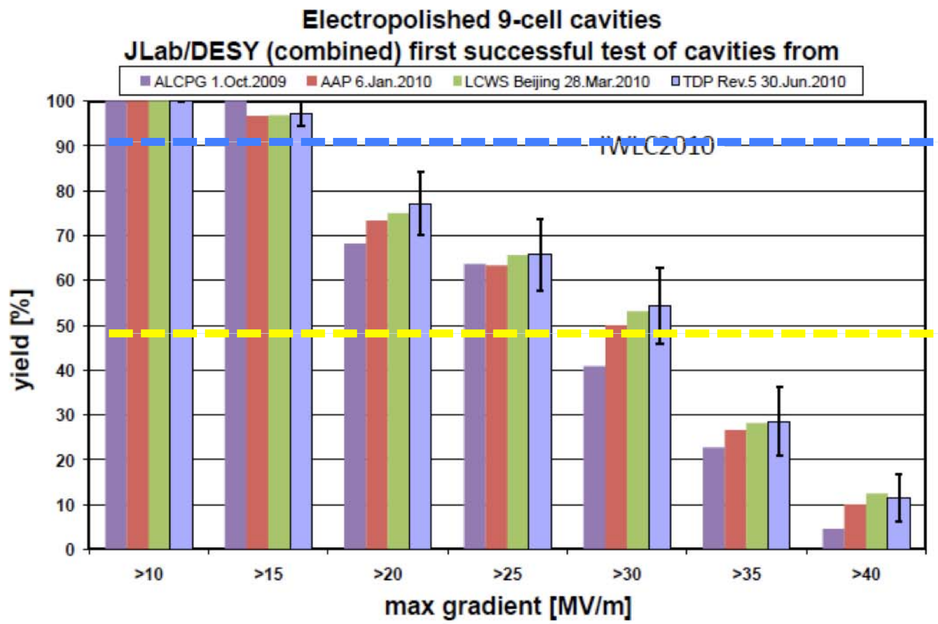
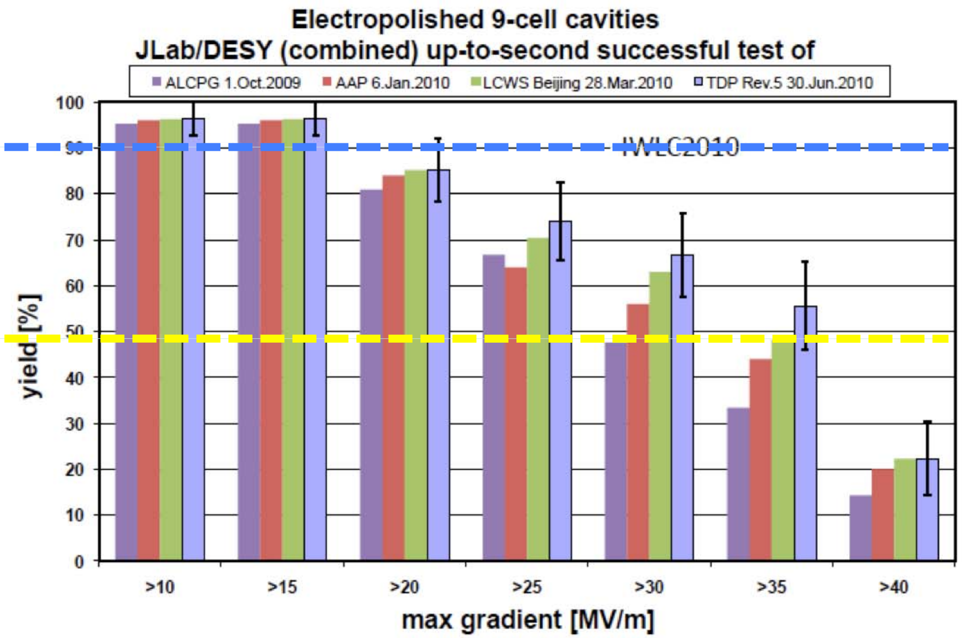
Preparation for Industrialization				Production Technology R&D		
Communication with industry:	2009: 1st step: Visit Venders (2009) 2010: 2nd step: Organize Workshop (2010) 2011: 3rd step: Send specification & receive response					

Progress of Cavity Gradient Yield

1.3 GHz, Fine-grain, 9-cell Cavity

by ILC cavity Data-Base Group, as of June, 2010





1st pass

2st pass

- Progress during a period of Oct, 2009 ~ June, 2010

ILC-ML SCRF Cavity Gradient Specifications Update

Cost-relevant design parameter(s) for TDR	ML cavity gradient Specification	R&D Milestone
9-cell Cavity Gradient in vertical test	35 MV/m, average - Spread: 28 – 42 MV/m (+/- 20 % or less)	35 MV/m at 90 % yield including 2nd pass, (eq. > 38 MV/m, average)
Cryomodule Operational Gradient	34 MV/m, average	34 MV/m, average CM Obs. G. Limit = 3 %
ML Operational Gradient	**<u>31.5 MV/m, average</u>** - Spread: 25 – 38 MV/m (+/- 20 % or less: TBD)	31.5 MV/m, average Op. G lim = 1.5 MV/m Cntrl margin = 3 %**
Required RF power overhead for control	10-15%	

Next Action to communicate with Industry

- The 3rd stage Plan for 2010-2011:
  - **Ask advices from cavity/cryomodule vendors**
  - **Make our own effort for industrialization at laboratories,**
- Process:
  - **Prepare a preliminary ILC Cavity/Cryomodule specification**
    - Including design parameter, plug-compatible interfaces, manufacturing process,
    - Requirement on quality control, production time scale, …
  - **Ask for advices on industrial models including cost evaluation (depending on vendor's capacity)**
    - Scale of production: **4,000 ~ 8,000** (25 ~ 50 %, as a typical scale)
    - Possible industrial collaboration (grouping etc..)
    - Scale of production period: **2 + 6 years** (pre-series + main production period, for example)

What we need to prepare for ?

- Establish cavity/cromodule specification including plug-compatible interface conditions and assembly/integration,
- Communicate with industry/laboratories through a process of ‘Call for Response’ to receive practical industrial models and cost-estimate in view of suppliers
- Make our own effort to find the best cost-effective manufacturing, satisfying quality control required,
- Establish our technical direction, industrial models, and cost-estimate, by the end 2011.

Manufacturing Process Spec.

2.2. Manufacturing specification

2.2.1. Cavity components and integration

The cavity manufacturing include main cavity cell, end-groups, He-jacketing, and further associate components such as tuner mechanism and input couplers and others are to be considered as supplied components by third suppliers and/or manufactured by main suppliers.

The cavity is manufactured according to the following process (each process to be futher described in detail).

{The following is an example list for more detailed description}

1) Nb sheet prepared: machined and inspected,
2) Half-cell/cup elliptically formed and inspected,
3) Half-cell/cup trimmed at both ends of iris and equator, and inspected
4) Half-cell/cup cleaned with BCP,
5) Dumb-bell shape formed by using EB welding, and inspected,
6) Multiple dumb-bell assembled by using EB welding, with multiple steps, to form 9-cells,
7) End-group (details are listed separately) assembled with 9-cell (central) cavities, and inspected,
8) 9-cell cavity transported to surface treatment
9) Surface process (detail process given separately) performed, and inner surface inspected,
10) Heat treatment for H degassing,
11) Field flatness tuning
12) The 2^{nd} surface process
13) Anntena assembly

Content

Outline

Abstract / Executive Summary

1. Introduction
2. Technical guideline
3. Specifications
4. Questions to manufacturers/Industry, calling for response
5. Summary

References:
R1. ILC Reference Design Report
R2. ILC Technical Design Phase, R&D Plan Release 5 (As of Aug. 2010)
R3. Report from

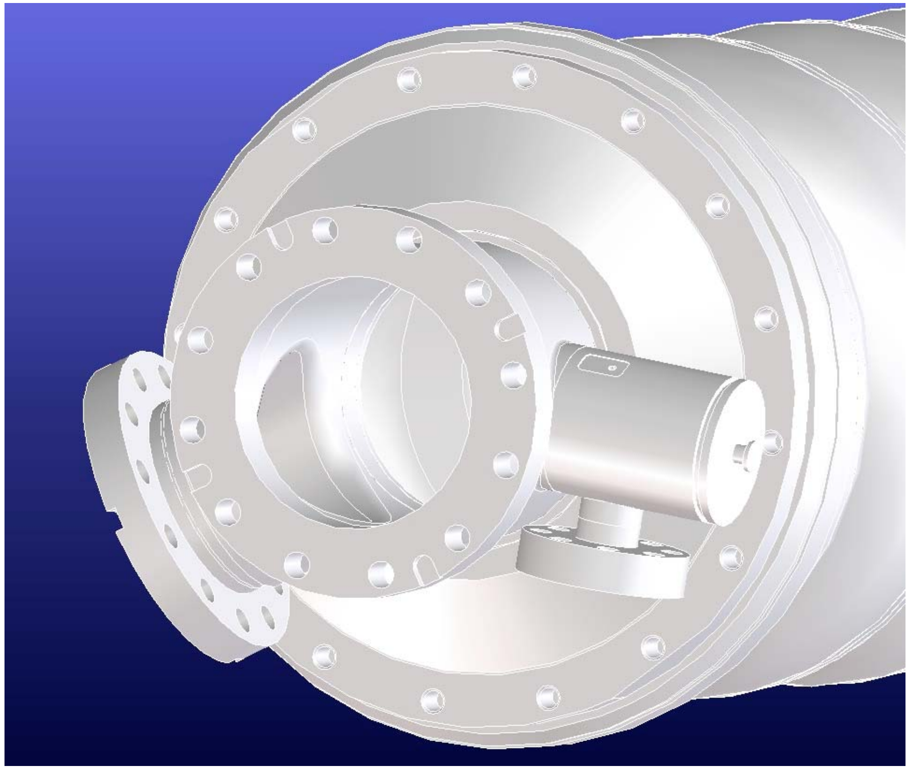
Appendices:
A1. Plug-compatible boundary conditions (internal report; SCRF)
A2. …

Objective of Industrial Study

- **We hope to develop the industrial model that would be the best for the cavity and cryomodule production for the ILC,**

- **This includes:**
  - The project-industry relationship
  - Quality control
  - Scale-up to production quantity
  - Cost--effective manufacturing
    - How many lines for EBW and others
    - Manufacturing ….

KEK-End-Group, KEK-HOM-coupler



At First, we started HOM coupler fabrication study

Deep drawing of cup

digital servomotor press advantage

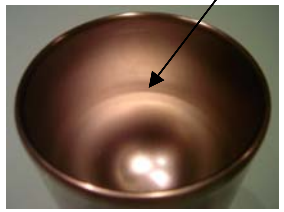
conventional press

TPL150

①plate → ②1st deep drawing → ③2nd deep drawing → ④3rd deep drawing

Φ165 0.5 t

shock-line

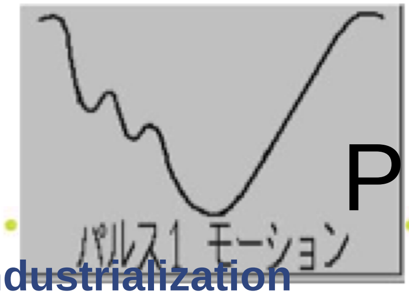


SDE1522

①plate → ② one deep drawing

Φ160 0.5 t

モーション設定	パルス1モーション
上昇移動量	0.1 mm
追い込み移動量	1 mm
繰り返し回数	30 回
加工ストローク数	10 min−1



no shock-line

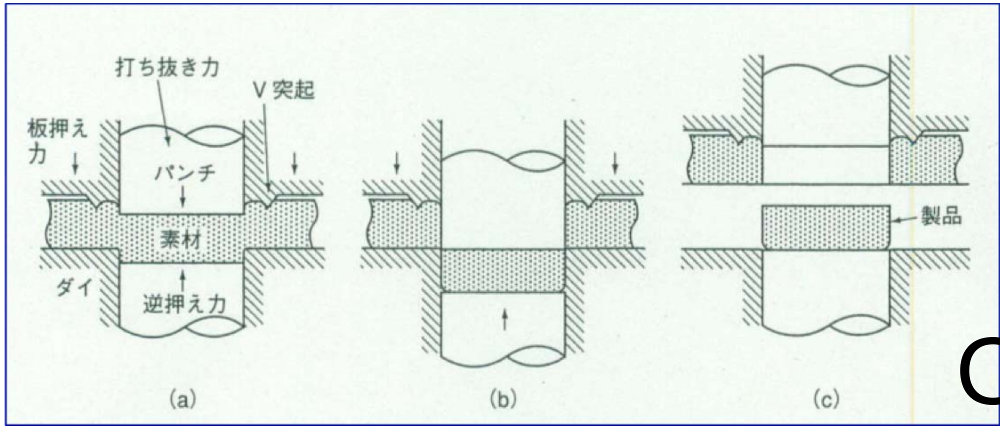
digital servomotor press

Pulse motion press

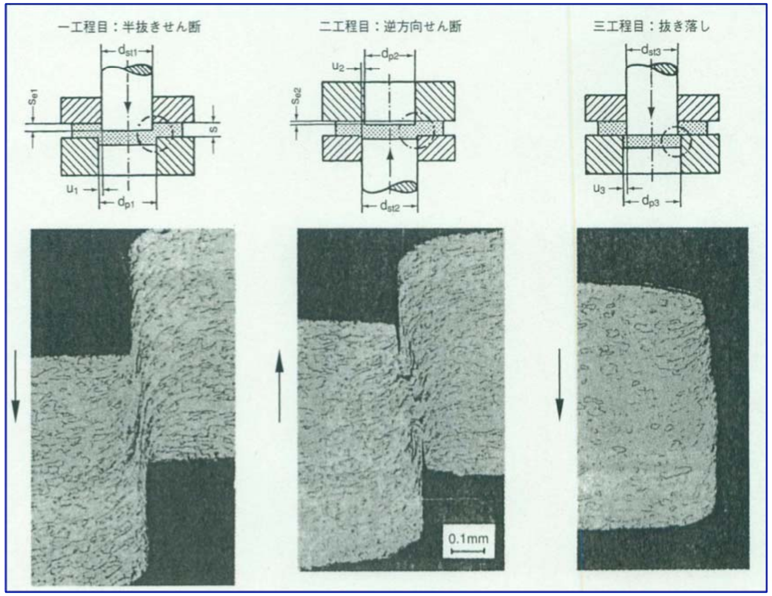
from Amada presentation

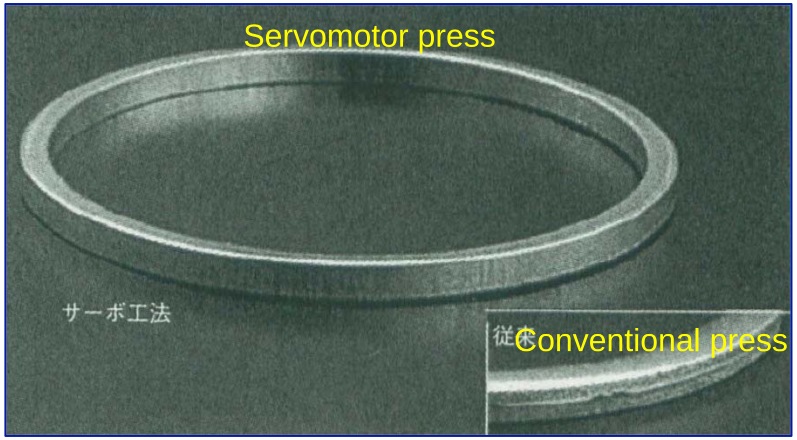
Fabrication by Fine-Blanking method (FB)

Thick plate Press-cut out without burr at c



One action FB



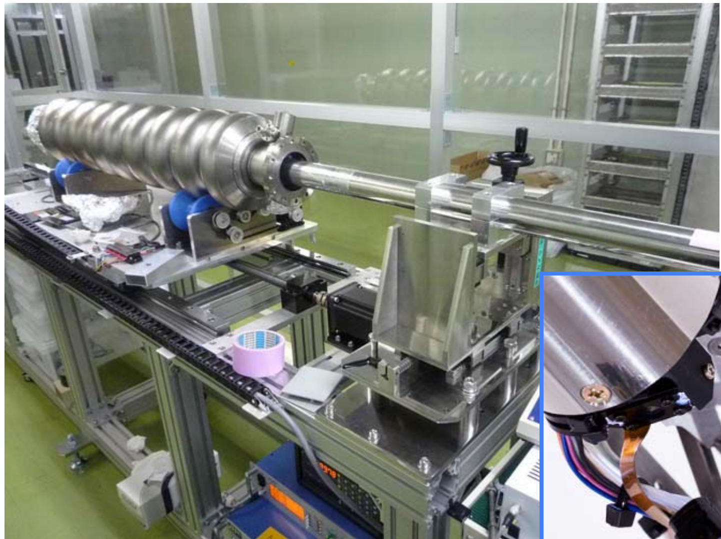


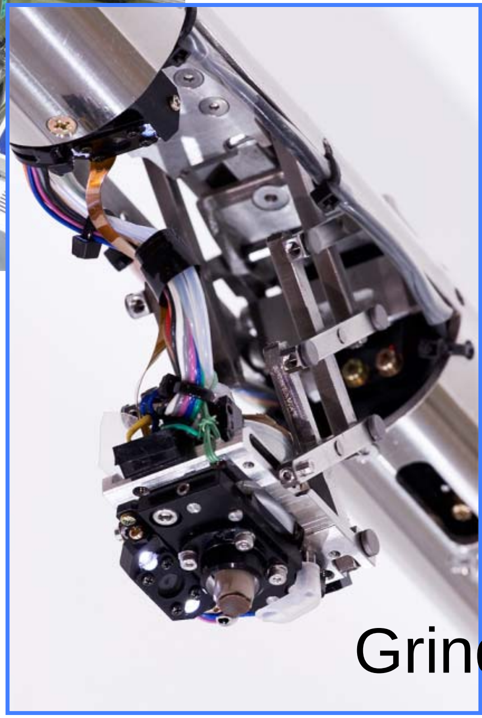
Combination of FB-meth

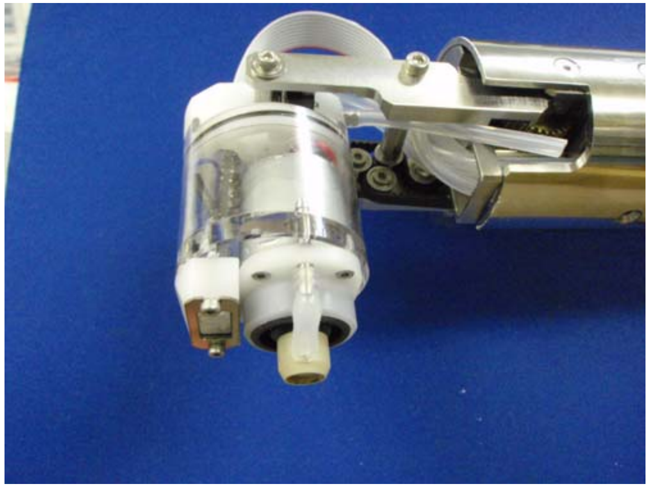
Three action FB method

Effort for Repairing: Grinding

Reported by H. Hayano at TTC, FNAL,April, 2010

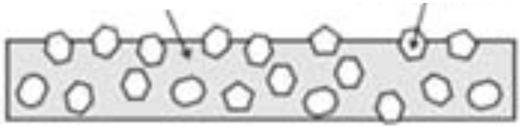






Grinder for slope surface

heat resistance resin Diamond particle



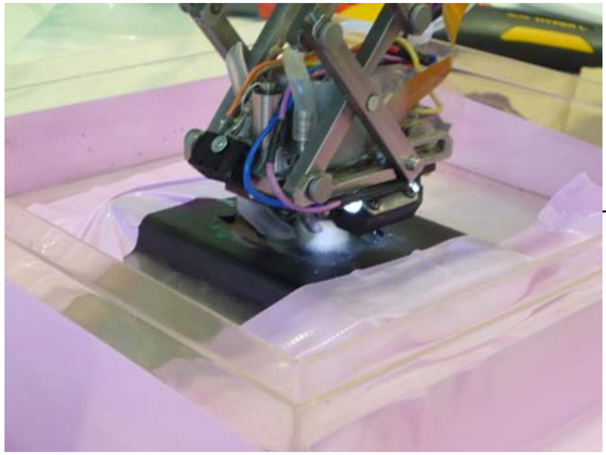
Polymond+water for grinding

Grinder for equator

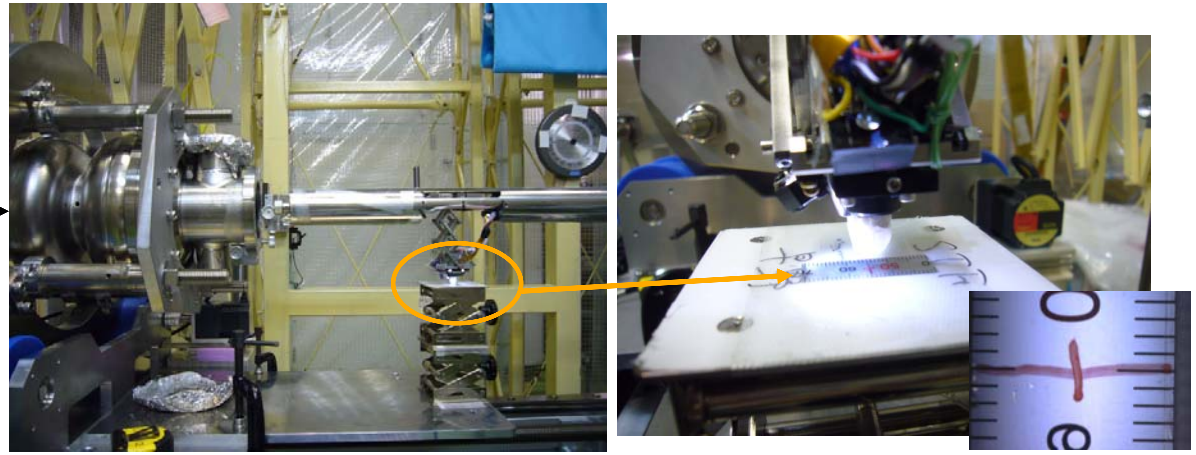
Material for grind：Diamond seat #400 - #3000

(particle size = 40 ~ 3 um), (POLYMOND)

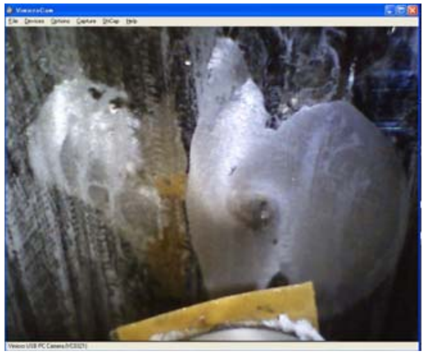
How to Grind for equator



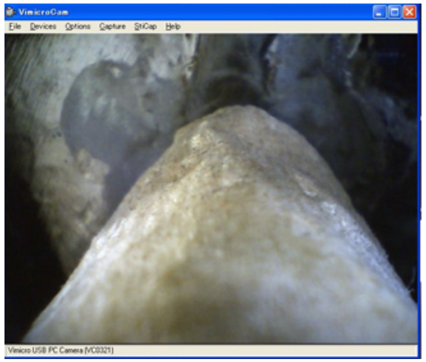
0.Grinding test using the replica, and check the shape after grinding.



1. Grinder head positioning to the target. The target monitered by using camera system.



Diamond sheet on the head



Wiping.

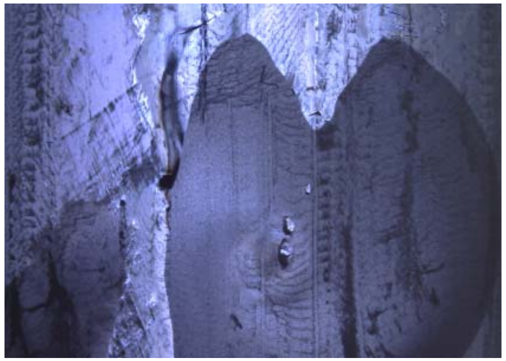
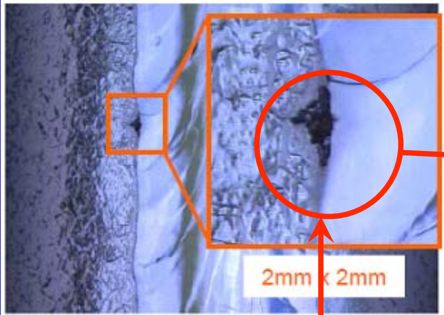


image capture by Kyto-camera

2. Repeat diamond sheet grinding with water, cleaning and taking a image by camera system until removing the defect.

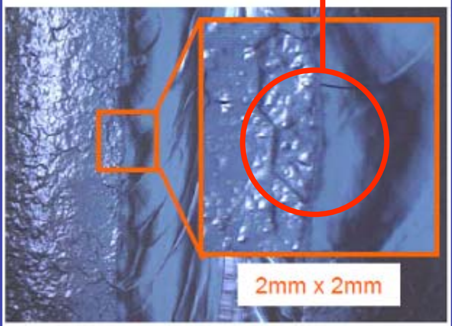
MHI-08 : The location of target for Grinding

Cell#2 equator, t=172 deg. Pit



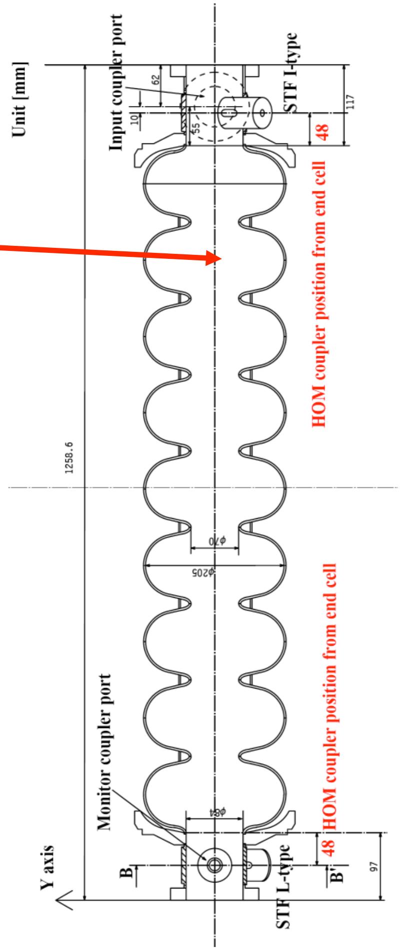
After V.T.

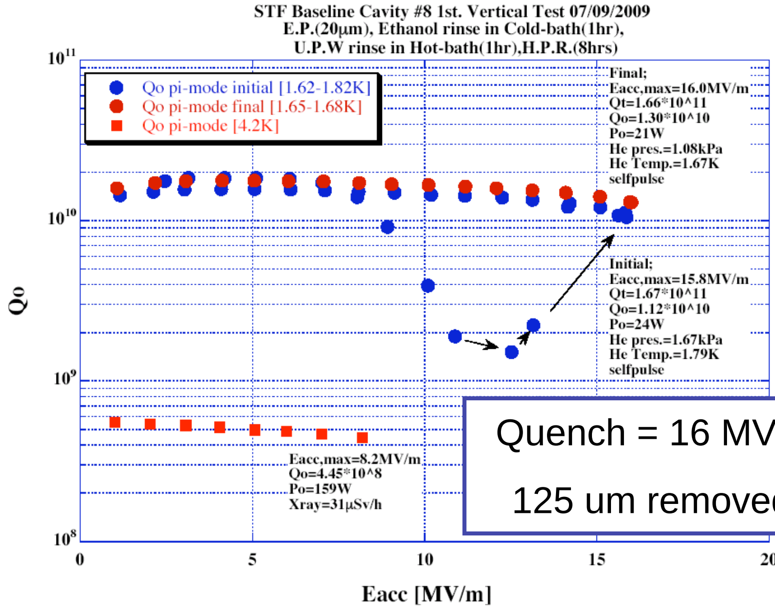
(Removed material = 125 μm)



Before V.T.

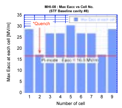
(Removed material = 105 μm)



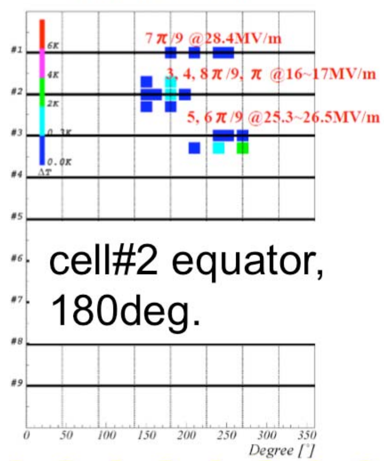


Quench = 16 MV/m

125 um removed.



MHI-08 1st V.T.



cell#2 equator, 180deg.

The cavity was quench at 16 MV/m on the cell #2 equator. The defect was made after EP-2 process.

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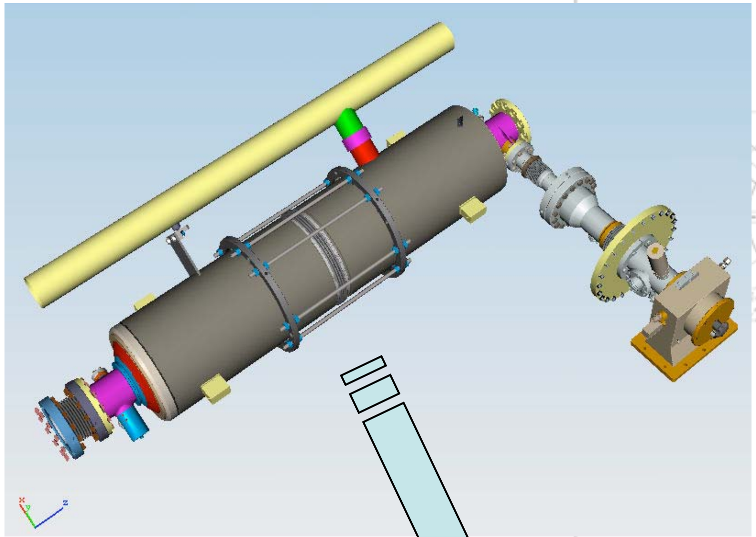
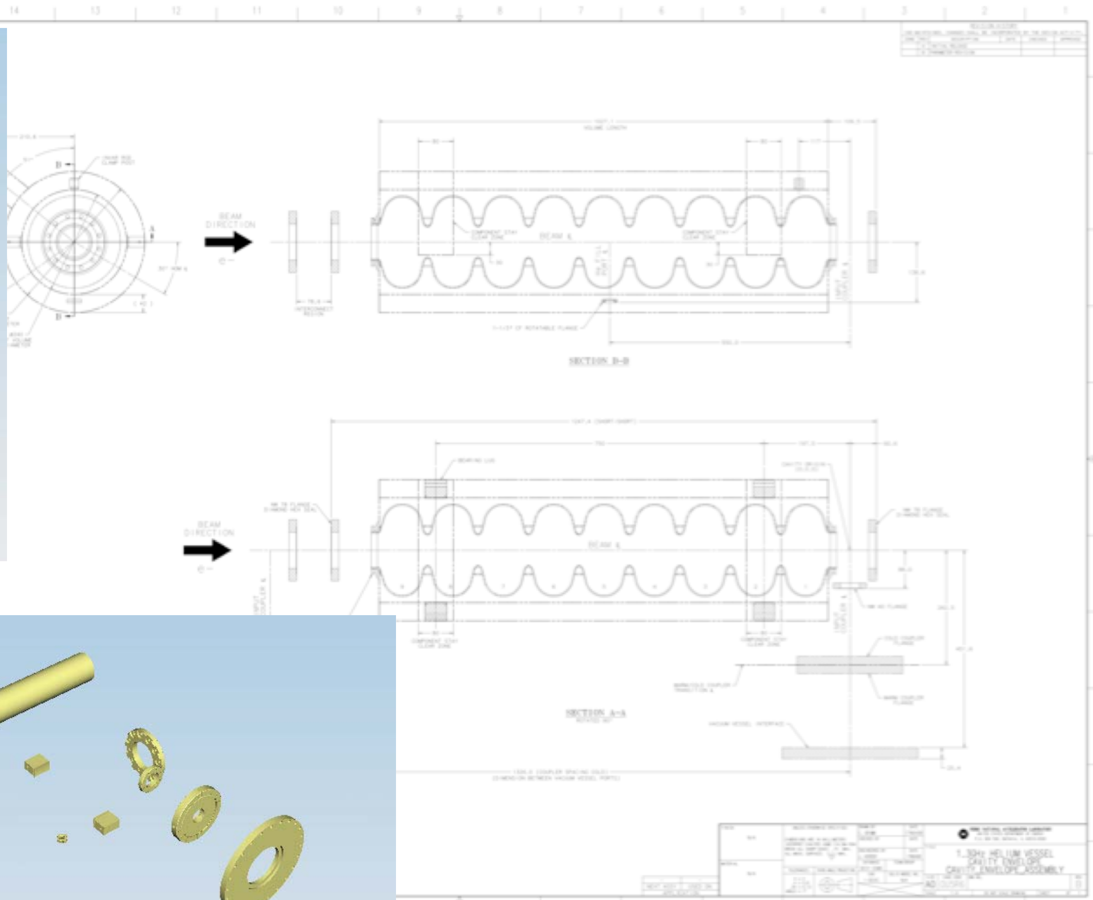
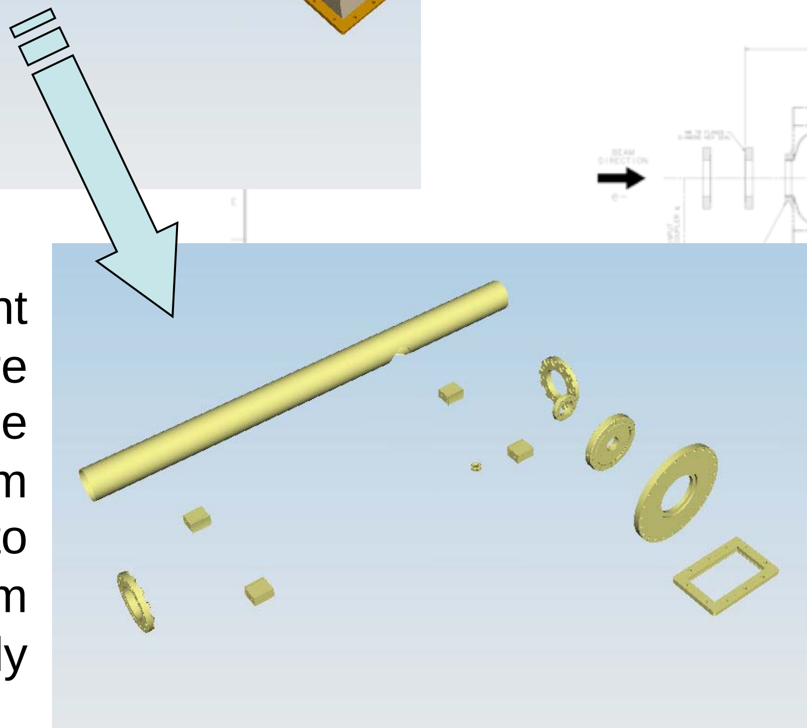
Cavity: Plug-compatible Interface





Component interfaces are reduced to the minimum necessary to allow for system assembly



Visits to SC Cavity Manufacturers in Global Industry: 2009

Europe:

RI (ACCEL)

ZANON

Americas:

AES

NIOWAVE

PAVAC

Asia

MHI

HITACHI (expected)

TOSHIBA (expected)

Notes:

AES: Advanced Energy Systems

RI: Research Instruments (previously, ACCEL)

MHI: Mitsubishi Heavy Industries

A Satellite Meeting at IPAC-2010

SCRF Cavity Technology and Industrialization

Date : May 23, 2010, a full-day meeting, prior to IPAC-2010

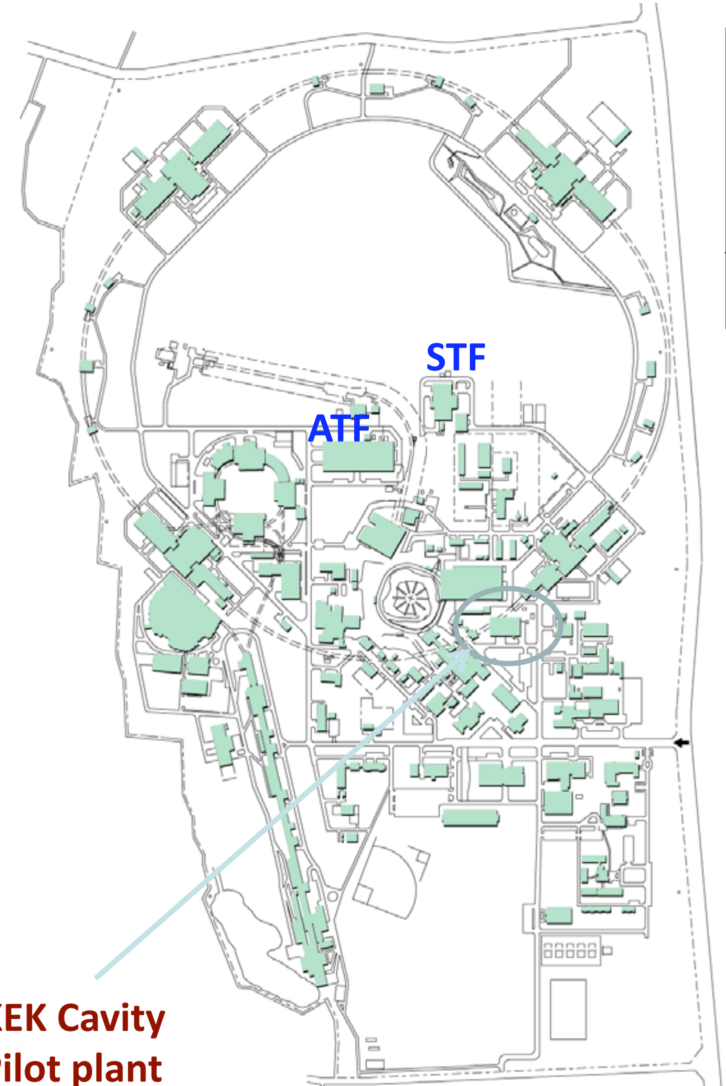
Place: Int. Conf. Center, Kyoto, Japan

Organized by: ILC-GDE Project Managers,

Objectives:

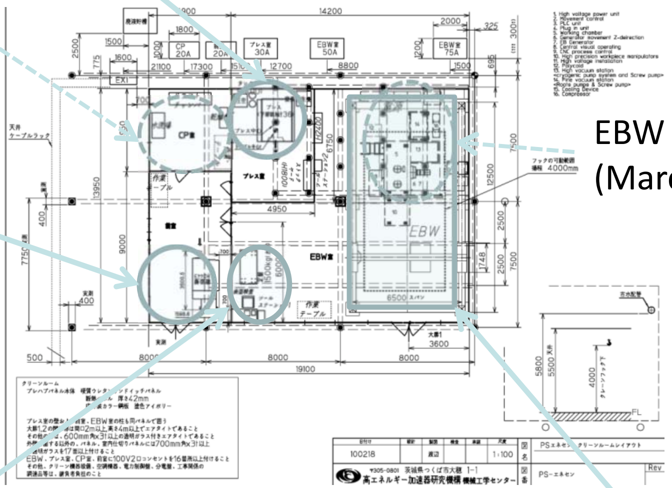
- To discuss and exchange information on:
  - **preparation for the 'ILC SCRF Cavity' industrialization between industries and laboratories,**
  - **Industrialization plan to be reported by laboratories, and**
  - **Comments/advices given by industries,**

KEK Pilot plant



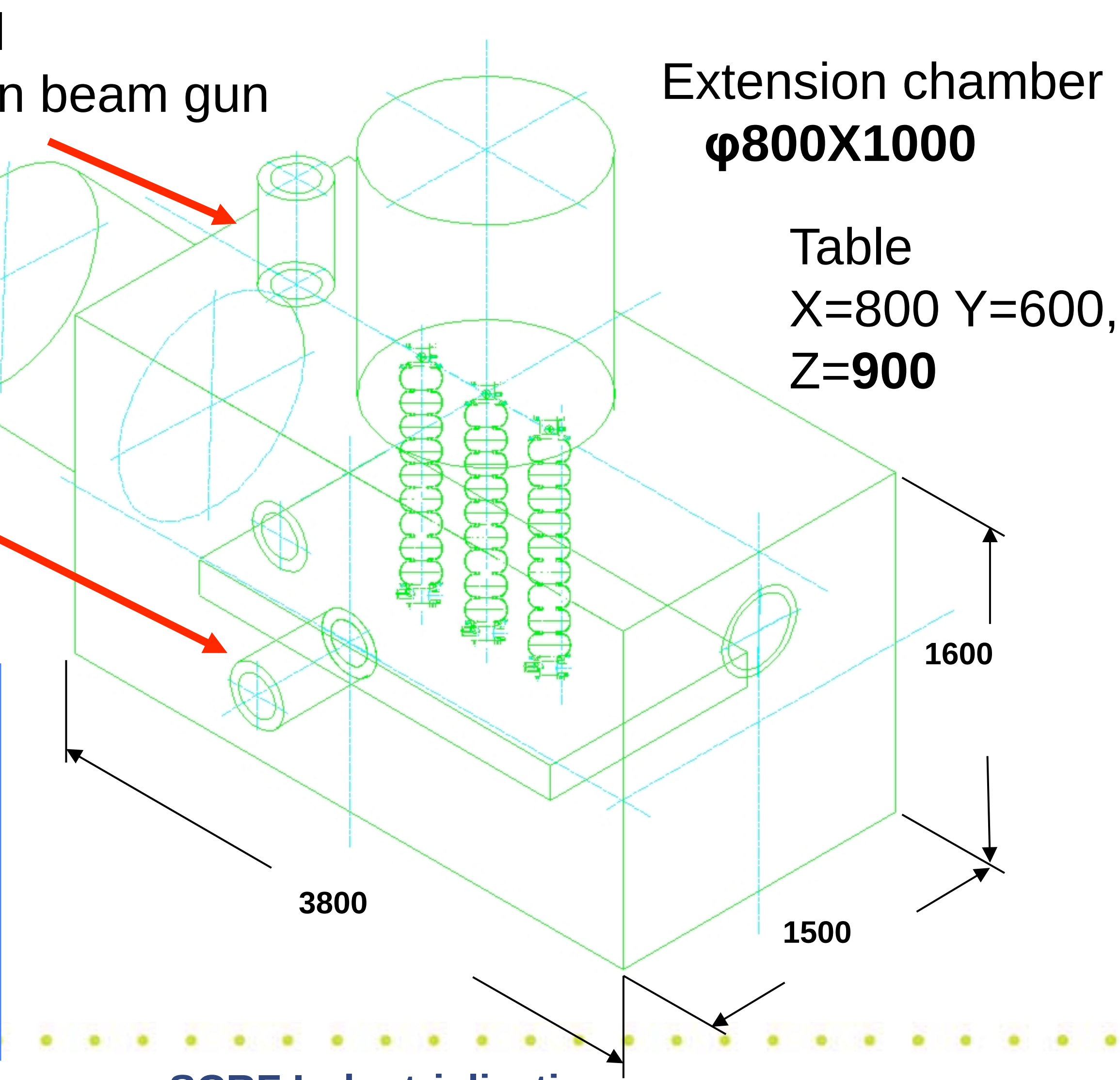
KEK Cavity Pilot plant

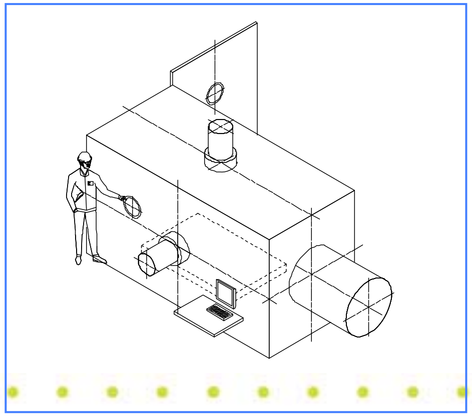
Building inside



Plant clean room

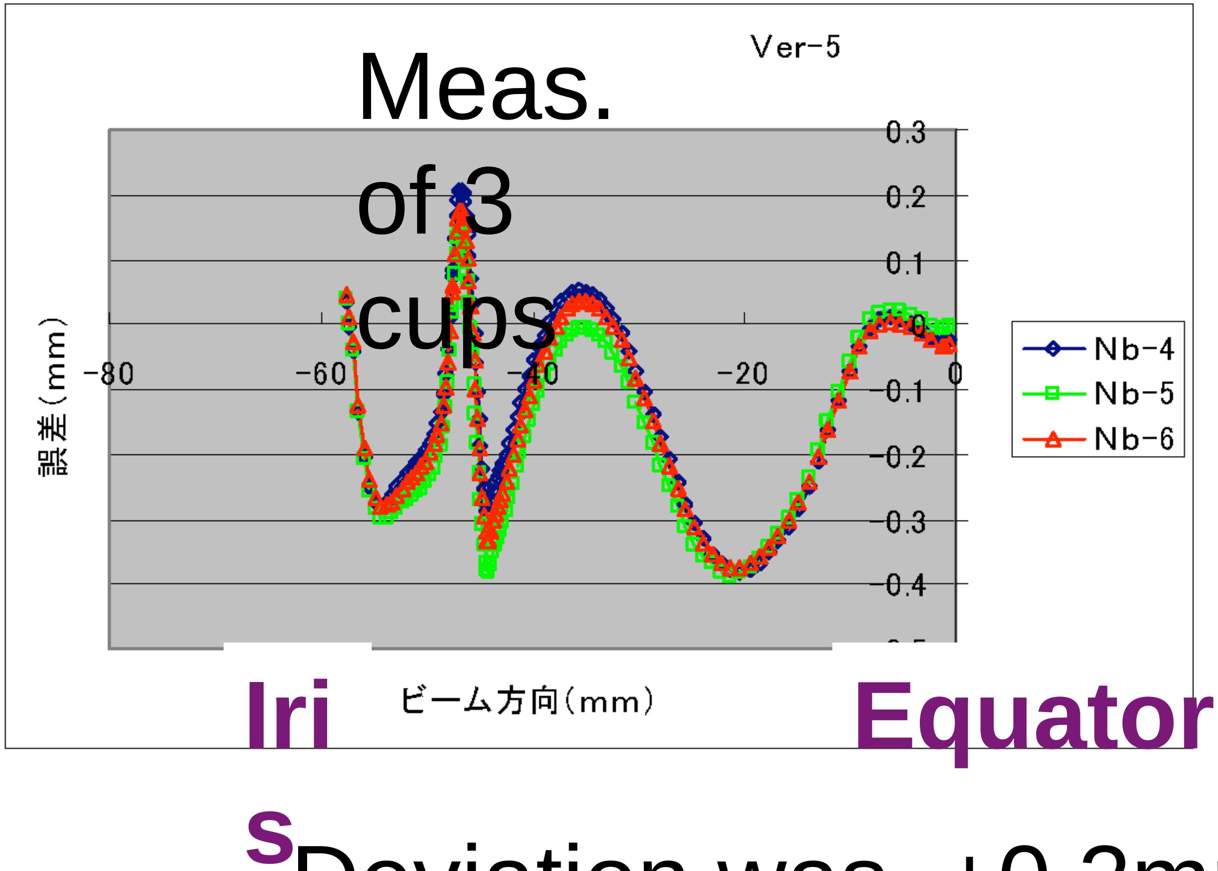
Possible EBW Facility at KEK





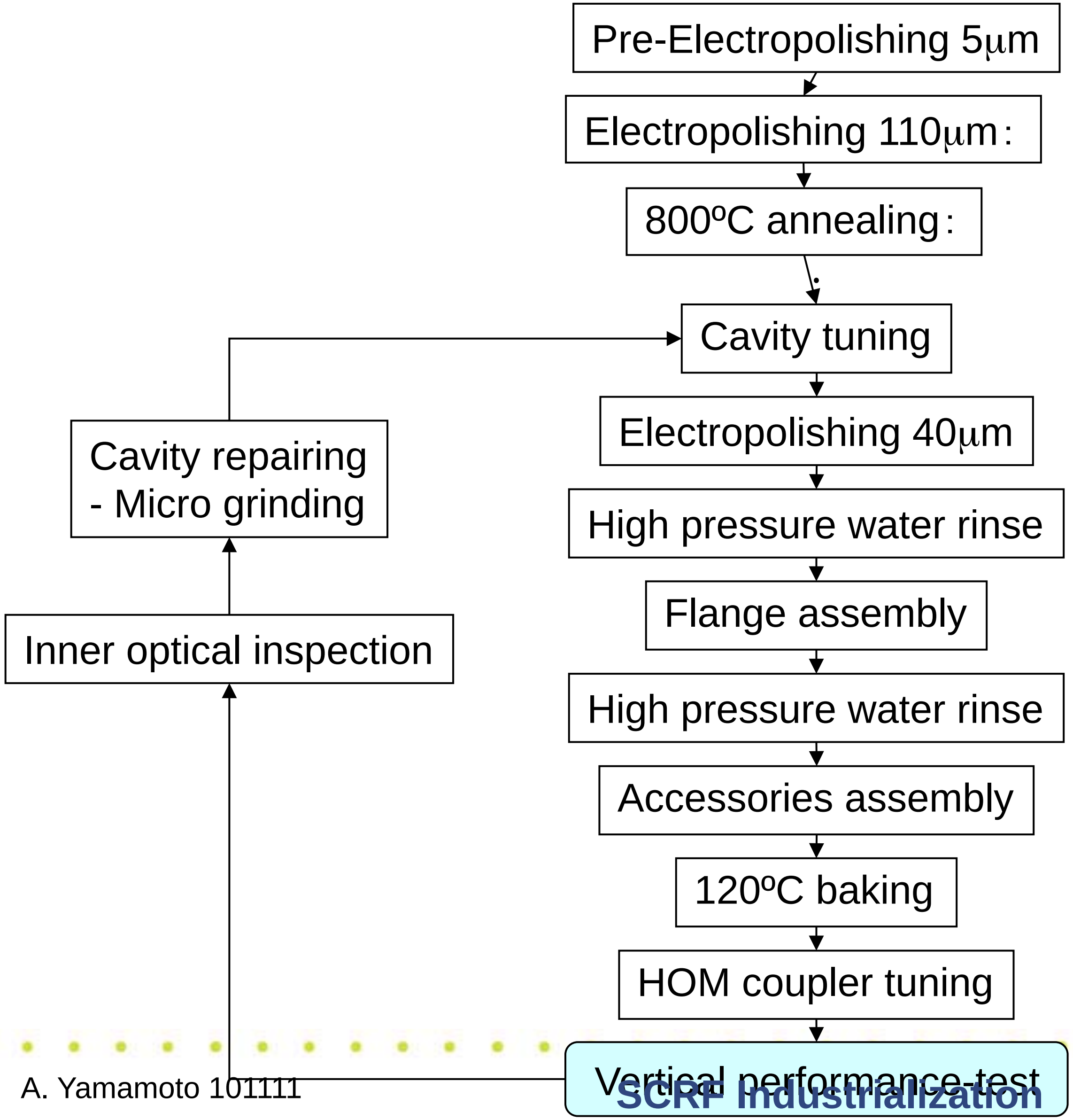
Deviation of cup-shape from the design shape

同金型（Ver-5）での３つのセルのばらつき

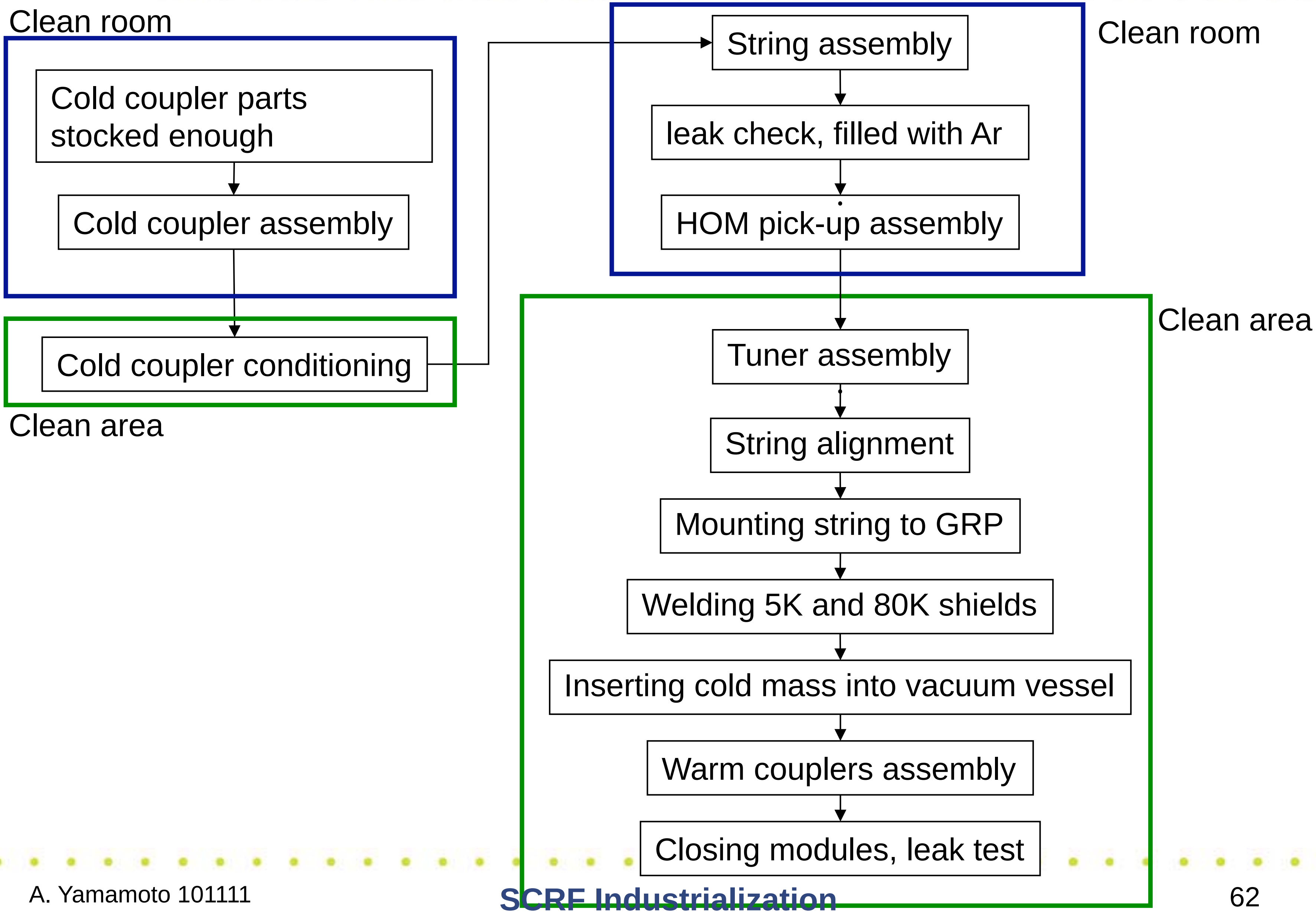


Deviation was +0.2mm ~ -0.4mm

Cavity Processing



Cryomodule Assembly



Cavity Fabrication

	actual run time (2 shifts) per day for each process	Number of machines (processes)					
		Case1		Case2		Case3	
		Yield %					
		100	90	100	90	100	90
Nb sheets eddy current inspection	16 hrs	1	1	1	1	1	1
Half-cell deep drawing	8	1	1	1	1	1	1
Half-cell trimming	16	3	3	3	3	3	3
Half-cell geometry check	8	1	1	1	1	1	1
Half-cell BCP for welds		1	1	1	1	1	1
Dumb-bell EB welding	16	5	5	2*	2*	2	2
End groups EB welding		5	5	5*	5*	2	2
9-cell cavity EB welding		2	2	1	1	1	1

* 2+5 → 6 in case of common EBW machine

Technical Design Phase and Beyond